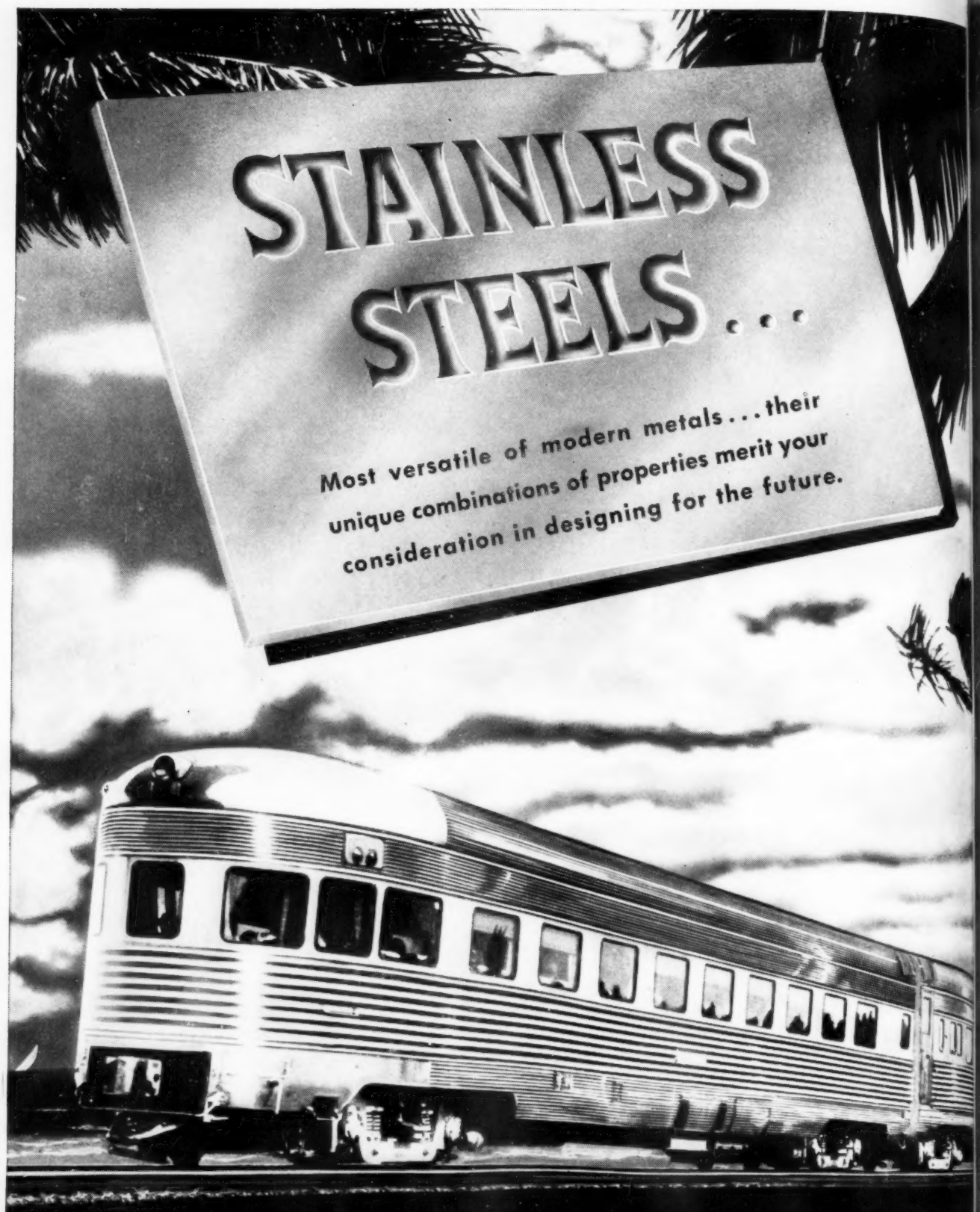
ARMY ORDNANCE

VOL. XXIX, No. 152 SEPTEMBER-OCTOBER, 1945

REAR ADM. GEORGE F. HUSSEY, JR.

Naval Ordnance is under his capable guidance

A REVIEW OF INDUSTRIAL PREPAREDNESS FOR NATIONAL DEFENSE
PUBLISHED BY THE ARMY ORDNANCE ASSOCIATION, WASHINGTON, D. C.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THE ARMY ORDNANCE ASSOCIATION

The Aims and Purposes of the Society

The Army Ordnance Association, a national society of over 45,000 American citizens, was founded in 1919, "pledged to industrial preparedness for war as our Nation's strongest guaranty of peace." The society was incorporated under the laws of the District of Columbia in 1928. Its entire energies are now dedicated to victory for the armed forces of the United States. For the duration of the war it is "pledged to victory—complete, absolute, final."

The Association has endeavored during the past twenty-five years to keep alive an interest in and knowledge of the design, production, and maintenance of military armament. This it has done through periods of public lassitude and times of great national emergency. Until 1940 there was no peacetime armament industry in the United States for the production of ordnance. Now all American industry is geared for victorious war production.

The principal objective of the society is an active membership of American citizens to assist in the design, development, procurement, production, maintenance, and supply functions of the Ordnance Department of the United States Army. When peace returns, this body of informed citizens will again continue to be a bulwark of knowledge, experience, and ability upon whom the Armed Forces of the United States can rely for technical and scientific assistance and for industrial preparedness.

The Association is devoted solely to the national defense; it has no commercial interests, no political alliances, and no religious affiliations. It is not operated for profit: its income is expended in furthering its aims. Its elected officers and directors serve without remuneration. Membership, to which American male citizens are eligible, is $10.00 for three years or $4.00 for one year. Local chapters of the Association are located throughout the United States.

The objectives of the Association as set forth in its Constitution are:

1. To assist in effecting industrial preparedness for war as being one of the Nation's strongest guaranties of peace;

2. To keep available the highly specialized knowledge necessary for arming the manhood of the Nation by stimulating interest in the design and production of ordnance material;

3. To promote mutual understanding and to effect coöperation with American scientists, inventors, engineers, and manufacturers in civil life, and the Regular and Reserve officers of the Ordnance Department;

4. To provide, when required, the services of competent committees to investigate and report upon special ordnance subjects;

5. To assist in developing and maintaining an efficient personnel, both commissioned and enlisted, for the units required for Ordnance Field Service in the event of an emergency;

6. To commemorate the services rendered by the industry of the Nation and by the officers and civilian employees of the Ordnance Department in the wars in which the United States has been engaged.

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THE OFFICERS, CHARTER DATES, AND HEADQUARTERS OF THE THIRTY-TWO CHAPTERS

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Boston, June 30, 1925

President: H. P. Richardson. Vice-Presidents: H. W. Bagnall, F. W. Knauth. Directors: The officers and Henry S. Chafee, D. F. Edwards, R. N. Greenwood, Milton P. Higgins, James L. Martin, C. S. Robinson, J. P. Spang, Jr., W. Stone, George Sweet, Thomas West. Secretary-Treasurer: G. P. Slade, 140 Federal Street, Boston 9, Mass.

Central Illinois, May 29, 1945

President: L. P. Weiner. Vice-President: J. R. Munro. Directors: J. M. Barkman, S. S. Battles, M. C. Budlong, F. E. Martin, Emil Norelius, V. T. Wissen. Treasurer: Merle Yontz. Secretary: Robert Hafer, Peoria Association of Commerce, Peoria, Ill.

Chicago, May 3, 1924

President: T. S. Hammond. Vice-President: John Slezak. Directors: E. J. Bush, W. E. Crocombe, W. H. Damon, Thomas Drever, Henry Isham, James Knowlson, C. A. Liddle, Fowler McCormick, Sterling Morton, F. A. Preston, W. R. Wright. Assistant Treasurer: K. L. Warren. Treasurer: G. D. Dearlove. Assistant Secretary: R. F. Doyle. Secretary: F. W. Renwick, Jr., First National Bank Building, Chicago 3, Ill.

Cincinnati, December 10, 1925

President: Frederick V. Geier. Vice-Presidents: R. G. Calton, Charles W. Dupuis, Louis Schwitzer, Sr. Directors: R. K. Brodie, R. H. Ferger, F. V. Geier, O. S. Hunt, E. A. Muller, Louis Polk, A. H. Pugh, Louis Ruthenburg. Treasurer: C. E. Grubb, Jr. Secretary: J. C. Shouvlin, Big Four Building, Cincinnati, Ohio.

Cleveland, October 25, 1940

President: C. F. Hood. 1st Vice-President: J. C. McHannan. 2nd Vice-President: W. M. Canaday. Directors: R. F. Black, F. H. Chapin, F. C. Crawford, D. S. Ellis, William Forster, B. F. Hopkins, A. D. Joyce, Frank Purnell, H. A. Roemer, G. W. Stephens, W. R. Timken, J. E. Trainer, A. J. Weatherhead, Jr., C. W. Williams, R. J. Wysor. Secretary-Treasurer: E. A. Lynn, 1006 Terminal Tower, Cleveland 13, Ohio.

Empire, April 29, 1938

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Hartford-Springfield, November 18, 1941

President: F. H. Payne. Vice-Presidents: E. B. Gallaher, C. H. Granger, S. C. Hope. Directors: G. H. Anthony, H. C. Beaver, E. P. Bullard, C. K. Davis, W. M. Goss, D. G. Millar, R. E. Pritchard, Edwin Pugsley, N. F. Ramsey, J. Y. Scott. Secretary-Treasurer: J. S. Begley, 95 State Street, Springfield, Mass.

Lehigh-Bethlehem, November 15, 1939

(Inactive for the duration.)

Lone Star, June 12, 1945

President: D. D. Day. Vice-President: A. J. Armstrong. Directors: E. H. Brooks, G. H. Brown, F. L. Lebus, Charles Medley, F. A. Pierce, H. S. Zane, Jr. Secretary-Treasurer: C. S. Barry, Jr., P. O. Box 2159, Dallas 1, Tex.

Western Electric racks its Electrical Brain

Western Electric engineers are not satisfied to know that the M-9 and M-10 gun directors are operating accurately when they leave the factory—they want to make sure they continue to function properly under the most trying conditions in the field. And so they devised the tumbling machine shown above to rack the electrical brain.

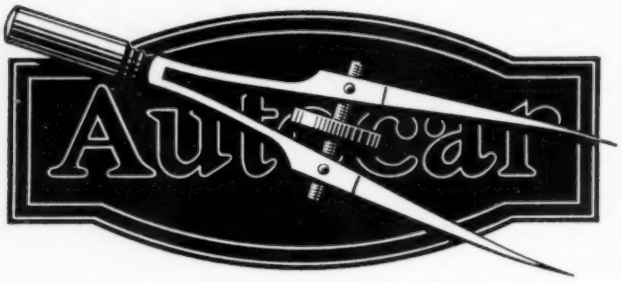
This machine tumbles the gun director ten times a minute, and submits it to a grueling series of shocks and jolts similar to those it will receive in transportation and handling at the front. Directors with the mechanical strength to pass this torture test are not likely to develop headaches for the men who use them in the field.

Known as the "electrical brain," the M-9 and M-10 gun directors were developed by Bell Telephone Laboratories in cooperation with the Army Ordnance Department, and are manufactured by Western Electric, one of the nation's largest producers of communications and electronic equipment for war.

Buy War Bonds . . . and hold them!

Western Electric

ARSENAL OF COMMUNICATIONS EQUIPMENT



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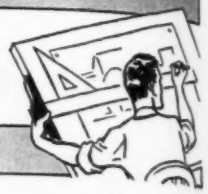
New Developments



RECOILLESS GUNS

Perhaps the most outstanding and revolutionary Ordnance development yet disclosed in World War II is the recently revealed recoilless gun, two types of which have been announced—the 75-mm. M20 model and the 57-mm. M18. The new weapons, which have absolutely no recoil, now give the Infantryman the striking power of field artillery. Elimination of ponderous recoil and recuperator mechanisms makes both guns light enough to be transported by two men.

The 75-mm. weapon weighs only 110 pounds and sends a 14-pound shell more than 4 miles. It is fired from a standard caliber .30 machine-gun tripod. The 57-mm. gun weighs but forty-five pounds and has a range of two miles with its 3-pound projectile. It is fired from the shoulder like the bazooka.

Recoil in both types is absorbed by allowing a controlled amount of propellent gases to escape through openings in the breech. (See frontispiece and other Ordnance photos in this issue by Al Muto; also articles describing the guns in detail.)

SUPERSONIC WIND TUNNEL

Lieut. Gen. L. H. Campbell, Jr., Chief of Ordnance, recently dedicated the largest supersonic wind tunnel laboratory in the world. The $2,000,000 laboratory, located at Aberdeen Proving Ground, Md., will specialize in bomb and artillery projectile projects for the concluding Asiatic phase of the war. The bomb tunnel is designed to produce air speeds of 1.7 times the velocity of sound, which travels at 1,087 feet a second. This means about 1,300 miles an hour. The ballistics tunnel will provide air speeds of about four times the speed of sound.

In the wind tunnel the bomb or projectile is held still, and the speed of the air around it is varied. This gives the same effect as moving through space but enables much faster and more accurate observations, which are especially important at supersonic speeds.

In addition to observations through portholes in the tunnels and microphone devices to record sounds in earphones, observations and photographs can be made by a Schlieren camera, which will take pictures at four-millionths of a second. This high-speed camera, using a carefully controlled beam of intense light, will photograph the pressure lines set up in the air by the model being tested.

The wind tunnel laboratory is part of the exterior-ballistics branch of the Ballistics Research Laboratory. Dr. Edwin P. Hubble is chief of the branch. He is the noted astronomer of Mt. Wilson Observatory and is serving in the Ordnance Department for the duration.

The first project in bomb testing paid off the entire cost of the installation. It was found that changes had to be made in a bomb design. This was done prior to mass production, thus saving taxpayers millions of dollars as well as substantially increasing the accuracy of the bomb. Also, as a result of wind-tunnel tests changes were made in the shape of a big gun projectile which increased the range by 3,000 yards.

SECRET GERMAN WEAPONS

Army Ordnance experts are making thorough examination of all German secret weapons and are questioning key German scientific personnel. These investigations are centered at Hillersleben, a large research and development center for artillery, and at Bad Blankenburg, another nerve center of Germany's research endeavors. (*Continued on p. 206*)

Photo shows paint treated with Paint-Gon ready to be hosed off

Turco Chemists Present Paint-Gon with 3 Outstanding Advantages

1. REGARDLESS OF THE MATERIAL UNDER THE FINISH— new Turco Paint-Gon is safe and non-corrosive to all widely used metals and wood; will not attack aluminum, magnesium, steel, cadmium, iron, zinc, or galvanizing; nor will it warp or raise the grain of wood.

2. REGARDLESS OF THE TYPE OF FINISH—new Turco Paint-Gon is effective on all kinds of coating—paint, enamel, baked enamel, varnish, lacquer, automotive synthetic enamel, baked varnish, air dry synthetic enamel, and even such stubborn finishes as baked urea alkyd and through the action of the stripper alone without scraping, scrubbing or brushing.

3. REGARDLESS OF THE CONDITION OF THE FINISH— new Turco Paint-Gon swiftly removes unwanted finishes, regardless of their condition, regardless of the number of coats, whether the finish is baked on by blistering desert sun, or cracked, or pitted.

Paint-Gon is swift in its action, removing coatings in five to twenty minutes so that it may be flushed away, leaving no gummy adhesive residue or film.

Paint-Gon may be applied by brushing, scrubbing or spraying; spreads easily and uniformly; clings well to vertical surfaces. It is non-inflammable (and does not require use of inflammable, volatile solvents), is water removable, exceptionally free-rinsing. Product itself is stable, non-separating, has no tendency to congeal, causes no trouble in shipping, storing, or handling.

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SV—Saponifying Value
SA—Solvent Action
CA—Colloidal Activity
WC—Water Conditioning
BI—Buffer Index
PH—Energy of Alkalinity
TA—Total Alkalinity
RE—Research and Experience, the combining factor that puts all the above elements into balance and to work on your specific problem.

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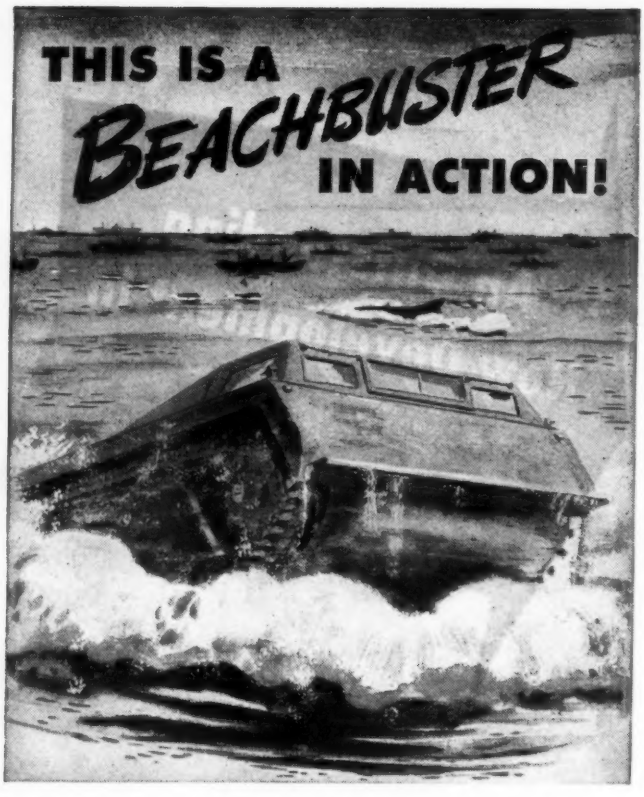

The "Beachbuster" is built by the Ingersoll Steel and Disc Division of Borg-Warner.

On embattled Pacific beaches the "Beachbusters" —amphibious arsenals of victory—batter their way over all obstacles to disgorge precious cargoes of fighting men and materials safely ashore.

REX-FLEX Inner Lined Exhaust Members are used in the "Beachbuster"—and with good reason: for these exhaust units of 18-8 Austenitic Stainless Steel have the *corrosion and heat resistance,* and the *stamina* for the toughest kind of military service. Write today for complete information about REX-FLEX Stainless Steel Flexible Metal Tubing.

ARMY E NAVY

Flexible Metal Hose for Every Industrial Use

CHICAGO METAL HOSE CORPORATION
MAYWOOD, ILLINOIS

Plants: Maywood and Elgin, Ill.

New Developments

At Hillersleben, Ordnance officers discovered a projectile which, though fired from a gun, became rocket-propelled after leaving the gun barrel. The Germans were also devoting much attention to new types of ammunition designed for ranges of ninety-four miles, although accuracy at this distance was expected to be poor.

Superheavy projectiles for standard caliber weapons was another project. The Germans had also developed a gun about thirty-two inches in diameter which was reported employed at the siege of Sevastopol but which was never brought into operation against American troops. It fired a shell weighing five tons.

At Bad Blankenburg, Ordnance experts are questioning 150 of the top scientists of Germany, headed by Prof. Walter Hermann, chief of the *Luftwaffe's* Technical Academy.

The Japanese are believed to be in possession of secrets of new German rocket weapons which, if the European war had continued six more months, might have made the airplane obsolete and might have been used to destroy American cities, it was revealed in Paris recently by Lieut. Col. John A. Keck, chief of the United States Army's enemy equipment intelligence section. These weapons, which it is believed might have altered the whole course of the war, include:

1. A rocket-propelled missile fired from the ground that would have been accurate to within 10 yards when firing at planes flying as high as 50,000 feet.

2. A modified version of the V-2 fitted with wings and having a range of over 300 miles.

3. A gigantic big brother of the V-2 rocket, capable of being fired from Europe to the United States and kept under radio control.

Among other German developments which might be used against us by the Japanese is an underwater V-2 rocket bomb which could be fired from a submerged submarine at distant targets such as cities.

Other novel German weapons included:

Large and unwieldy tanks which could be easily outmaneuvered by the smaller allied tanks—one of these, called the "Mouse," weighed 200 tons;

A large number of 400-foot-tube guns ranged along the French coast to fire shells at London;

Eighty-eight millimeter shells fitted with disintegrating bands which made it possible to fire them from larger caliber guns, thus giving the guns greater range at no sacrifice of explosive power;

A rifle with a curved barrel for shooting around corners.

STEEL TUBING IN GUN MECHANISMS

Seamless steel tubing employed for the first time in this war to make the hydropneumatic recoil mechanism on field artillery pieces has simplified and speeded up production of guns for the allies. The use of tubes superseded the method which had been used for the past fifty years, ever since the hydropneumatic recoil was developed in the 1890's.

This method involved cold drilling, by hand lathes, through a solid steel bar between six and seven feet long—a process requiring about eight hours. Today the hole in the tube is made in five seconds by special rotary piercing machinery. Thus the switch to tubing has allowed substantial saving in machine tools and man-hours of labor.

SIX-ENGINED TROOP TRANSPORT

A new 6-engined cargo plane, the XC-99, readily adaptable as a hospital plane or as a troop carrier with a capacity of several hundred soldiers, has been developed for the Army Air Forces by Consolidated Vultee Aircraft Corporation of San Diego, Calif.

The giant XC-99 has a wing span of 230 feet, a length of 183 feet, and is powered by 6 pusher-type power plants. It is the

THE BIRD WITH THE 16-MILE TAIL

The wire you see with the parachute on the end of it is a telephone wire, being payed out from a C-47 plane.

Bell Telephone Laboratories, working with the Air Technical Service Command of the Army Air Forces, developed this idea. It will save precious lives and time on the battlefield.

A soldier throws out a parachute with the wire and a weight attached. The weight drops the line to the target area. From then on, through a tube thrust out the doorway of the plane, the wire thrums out steadily — sixteen miles of it can be laid in 6 2/3 minutes. Isolated patrols can be linked quickly with headquarters. Jungles and mountains no longer need be obstacles to communication.

This is in sharp contrast to the old, dangerous way. The laying of wire through swamps and over mountains often meant the transporting of coils on the backs of men crawling through jungle vegetation, and in the line of sniper fire. It is reported that in one sector of the Asiatic theater alone, 41 men were killed or wounded in a single wire-laying mission.

Bell Telephone Laboratories is handling more than 1200 development projects for the Army and the Navy. When the war is over, the Laboratories goes back to its regular job — helping the Bell System bring you the finest telephone service in the world.

BELL TELEPHONE LABORATORIES

Exploring and inventing, devising and perfecting for the Armed Forces at war and for continued improvements and economies in telephone service.

"WHY DIDN'T SOMEBODY TELL ME,"

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"THAT THESE THINGS ARE PROTECTED BY **PERMITE ALUMINUM PAINT?"**

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PERMITE READY MIXED ALUMINUM PAINTS

New Developments

military version of Consolidated Vultee's Model 37, the 204-passenger airliner contracted for by Pan-American World Airways for postwar transoceanic service. The XC-99 has a tricycle landing gear, pressurized cabins, and will have a service ceiling of 30,000 feet.

FIREBALLS

Auxiliary fuel tanks filled with jellied gasoline have proved highly effective as incendiary bombs in the Pacific. Carried under the wings of P-47 fighters like ordinary jettisonable tanks, they explode on striking the ground and splash flaming gobs of gel gas over a large area. The newly adopted missiles are often called "balls of fire."

UNDERWATER OIL SUPPLY

American productive capacity and technical know-how aided the British Government in achieving a modern engineering wonder, the laying of twenty 3-inch oil pipe lines under the English Channel to supply allied armies with oil soon after they landed on the Normandy coast.

The project of piping oil under the Channel to supply an allied fighting machine doing battle on another continent was conceived by Lord Louis Mountbatten in April 1942. The lines carried an average of 1,000,000 gallons a day during the campaign.

P-38 LIGHTNING PATHFINDER

A new P-38 Lightning lead plane that pinpoints targets through fog, darkness, and bad weather for formations of high-flying conventional Lightnings with heavy bomb loads can now be disclosed. Termed the Pathfinder, the modified 2-place Lockheed fighter carries equipment still not releasable but revealed to be so effective that Lightning fighter-bomber sorties have been able to wipe out invisible enemy targets. The 425-mile-an-hour plane carries 4,000 pounds of bombs and mounts 4 caliber .50 machine guns and a 20-mm. cannon.

THE LAVA FIRE BOMB

A new incendiary bomb which spouts synthetic lava is the latest contribution of the Chemical Warfare Service to the aërial war against Japan. Officially designated the M74, this 10-pound tube regurgitates its complex interior a few seconds after landing on an enemy war plant, immediately following which a blend of violently inflammable chemicals flows over the target like natural lava erupting from a volcano. One of the ingredients is "goop"—magnesium powder coated with asphalt particles—which is an intermediate product in making high-grade magnesium.

The lava bomb resembles a 19-inch length of hexagonal pipe. At one end is a collapsible metal tail which springs open when the bomb is released from its cluster. Inside the bomb is a plastic cup which holds half a pound of white phosphorus, a few pounds of the synthetic lava filling, and a dome-shaped ejection diaphragm. Blown open by a burster charge, the diaphragm works like a piston, expelling itself, the cup of phosphorus, the lava, and the collapsible tail out of the bomb in a miniature eruption.

ORDNANCE TRAILERS

Streamlining transport operations for the final drive on Tokyo, the Stockton (Calif.) Ordnance Depot has developed a trailer train that will save American taxpayers $600,000 in one year. This has been done by converting 150 obsolete 37-mm. gun carriages into serviceable trailers at a cost of $70 each. Soon after the tractor-drawn trailer train went into operation, supplanting the truck-haul system formerly employed, 172 trucks and drivers were released for other work. *(Continued on p. 210)*

THE WORKHORSE OF HUMAN PROGRESS

Trucks, wherever you find them, are the true harbingers of universal progress. Fresh from phenomenal accomplishments in wartime service, these vital links in the nation's life line are ready for the new horizons of a peacetime world. Fortified by the lessons learned in the business of hastening Victory, new records of efficiency are in the offing ★ Come what may, modern control is destined to play an increasingly important part in each new step of transportation development. And that's where Air Brakes by Bendix-Westinghouse come in. For here is a time tested product whose safety, dependability and economy have always been in advance of transportation progress ★ You can count implicitly upon genuine Bendix-Westinghouse Air Brakes and Pneumatic Controls to give you a constantly dependable stopping force tailored exactly for the job at hand. Your nearest Authorized Bendix-Westinghouse Distributor will be pleased to consult with you relative to any control problem you may have.

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AND PNEUMATIC CONTROL DEVICES

IT IS SIGNIFICANT THAT AMERICA'S FINEST MOTOR TRUCK FLEETS ARE EQUIPPED WITH BENDIX-WESTINGHOUSE AIR BRAKES

"HANDY MAN" of the Ground Crew

It's a big help in getting planes serviced fast, this special high-speed military model Oliver "Cletrac" crawler tractor. Nicknamed the "bomber's nurse," its versatility and all-around usefulness make it a valued "handy man" to ground crews.

In addition to its primary job of hauling planes, the Oliver "Cletrac" military tractor is a highly maneuverable service station on wheels. It has an energizer for starting the plane motors; an air compressor to inflate tires and service shock absorber struts; a power generator for the operation of flood lights, grinders, drills, and other small electrically operated tools; and a front-mounted winch to handle or hoist heavy materials.

The speed of this Oliver "Cletrac," plus the maneuverability and ease of handling provided by its controlled differential steering, enables it to get the planes off the runways and into the dispersal area *fast.*

The ability of Oliver "Cletrac" tractors to operate efficiently under all types of service conditions . . . in muddy, sandy, or icy ground . . . has made them a valuable addition to our armed forces and makes them equally valuable at home for road building, excavating, mining, logging or hauling tasks. **The OLIVER Corporation,** Industrial Division, 19300 Euclid Avenue, Cleveland, Ohio.

OLIVER - Cletrac

New Developments

New 10-ton trailers were then converted to depot use. These are now in operation hauling large boxed vehicles and saving twenty-five per cent in time and cutting operational costs forty per cent.

X-RAY INSPECTION OF ROCKET POWDER

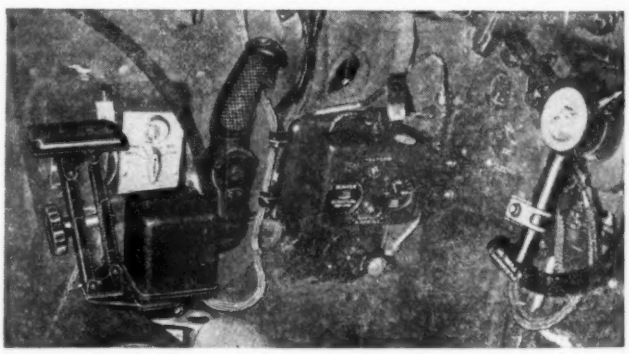
Regular industrial X-ray equipment—redesigned for the Navy's $100,000,000-a-month schedule of military rocket procurement—is speeding the inspection of rocket powder. This equipment, built at the Baltimore plant of the Westinghouse Electric Corporation in less than ninety days, makes possible rocket charges free of flaws, a characteristic never before attainable because of occasional and unavoidable air pockets deep within the powder grain. In service at the Sunflower Ordnance Works, operated by Hercules Powder Company at Eudora, Kans., the equipment makes a high-speed internal inspection of every extruded powder grain, providing a film record showing any flaw.

COLD TREATMENT FOR ARMY PLANES

The world's coldest climate—110 degrees below zero—will soon be "manufactured" in a new Army test laboratory at Wright Field, Ohio, to help weatherproof U. S. fighting planes for action in the bleakest regions on earth. Behind the steel-clad walls of four massive chambers, Army research men can freeze a drum of ordinary gasoline solid or test the ability of high-powered aircraft engines to start on a subarctic morning. Each piece of equipment that plays a part in engine starting must now pass this new cold test. Two of the smaller chambers are about the size of a spacious living room with a 12-foot ceiling, and the two largest cold rooms are thirty-six feet long and sixteen feet wide.

A NEW AIRCRAFT CONTROL STICK

An electronic control stick, described as the "most revolutionary advance in the flying of an airplane," has been designed by the Air Technical Service Command and the Minneapolis-Honeywell Regulator Company for use on heavy 4-engined bombers, including the new B-29 Superfortress. The new 1-hand control permits pilots to fly their aircraft with an ease and accuracy hitherto unattainable even in the smallest planes.



The formation stick mounted in a B-24 bomber.

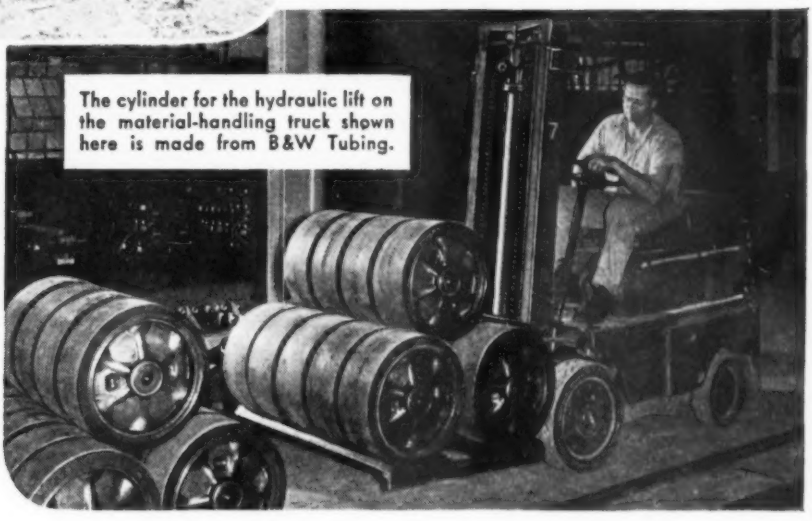
Called a "formation stick," the control is a pistol-gripped lever about ten inches long mounted with an armrest beside the pilot. It is free to move in all directions in exactly the same manner as the joy stick of pursuit aircraft. Through electronic amplification and the servo motors of the control surfaces, the stick moves the airplane in the same direction—and in the same proportion—as the stick itself is moved.

The new instrument not only greatly reduces pilot fatigue but also, through its ease of operation, simplifies the task of evasive action where pilots must change flight direction fre-

Tank track "pins" are among the many war equipment parts being made from tough, durable B&W Tubing.

Official U. S. Army photograph

in feet for tanks



The cylinder for the hydraulic lift on the material-handling truck shown here is made from B&W Tubing.

and arms for trucks

...B&W TUBES SAVE WEIGHT...CUT COSTS

Production of many war-vital products has been speeded up . . . precious time and materials saved . . . by making machined and structural parts from B&W Tubing. Items once made from costly-to-handle bar stock and forgings are being turned out faster and cheaper from dimensionally accurate, easily worked seamless and welded mechanical tubing.

Because of its high strength-weight ratio, use of tubing makes possible important weight savings in construction without sacrificing ruggedness.

In the host of new and unusual war production problems successfully solved by B&W Mechanical Tubing, manufacturers of peace-time equipment will find many adaptions that will help produce better products at lower costs with less waste of material. Now is the time to look into the production short-cuts that tubing makes possible.

From its modern specialty tube mills, B&W can supply mechanical tubing—both seamless and welded—for making any hollow machined or fabricated part. Let us know what you plan to make and we will gladly tell you how B&W Tubing can save you time and money.

B&W TUBES

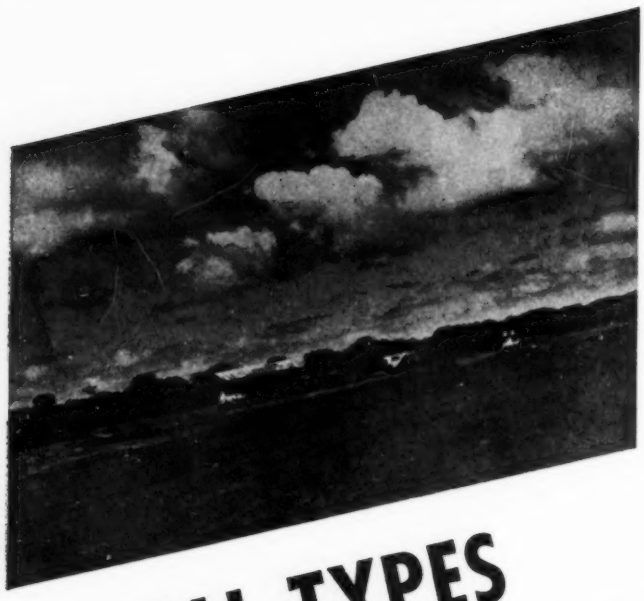
SEAMLESS. Complete range of carbon, alloy and Stainless steels. Sizes ½ in. to 8⅝ in. O.D.
ELECTRIC-RESISTANCE WELDED Carbon steel grades. Sizes: ⅜ in. to 4 in. O.D.

THE BABCOCK & WILCOX TUBE CO.

Welded Tube Division, Alliance, Ohio — Seamless Tube Division, Beaver Falls, Pa.

B&W MAKES BOTH

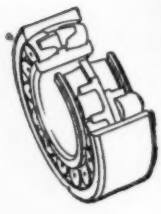
TA-1334



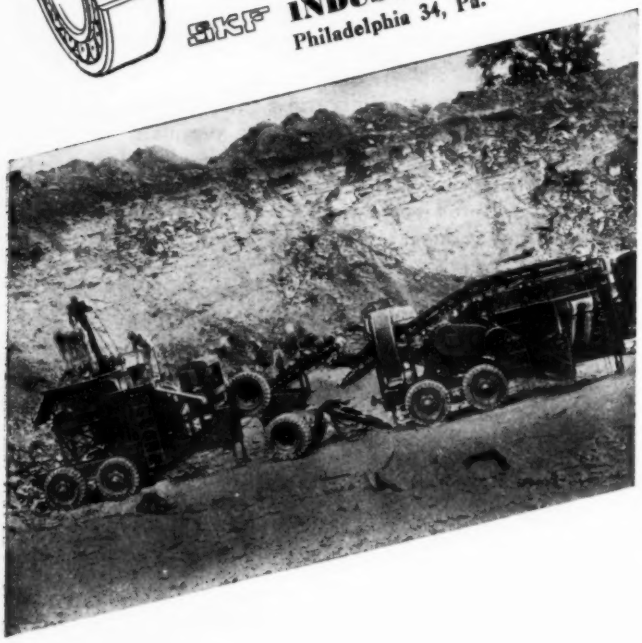
ON ALL TYPES
OF FIGHTING EQUIPMENT

The use of SKF Bearings is not restricted to guns, tanks, trucks, armored cars, etc. It's an important factor in the building of landing strips and roads. On bulldozers, tractors, shovels, etc., you'll find SKF Bearings standing up in hard, grueling work on rush schedules.

5857



SKF
ROLLER BEARINGS
SKF INDUSTRIES, INC.
Philadelphia 34, Pa.



quently to avoid antiaircraft fire. In addition the stick makes possible tighter formation flying, avoids "straggling," and permits an entire flight of aircraft, no matter how many in number, to turn as a unit with greater flying ease.

ALL-PURPOSE FIELD PACK

A new all-purpose field pack that enables a soldier to carry more equipment with greater ease is being procured for issue to fighting troops. The item is a combination of combat pack and cargo pack, both made of heavy duck and chemically treated for water repellency and mildew resistance. The combat pack is normally taken into battle, while the other may be left in a rear area until needed. The cargo pack, designed to hold full field equipment, is attached by adjustable belts below the combat pack.

BASE FOR FLIGHT LABORATORIES

A base for flying laboratories designed to speed through scientific and mechanical tests new military and civilian aërial developments, such as the actual harnessing of jet-engine and gas-turbine power for new-type planes, will be established at Schenectady County Airport by the General Electric Company. Already scheduled for test are jet engines and gas turbines, aircraft armament, autopilots, electronic devices, aircraft instruments, electrical power systems, communications and power apparatus.

NEW JUNGLE BOOT

An improved tropical combat boot has been developed by the Quartermaster Corps to replace the present rubber-soled jungle boot, the entire upper half of which was made of canvas. The new boot is equipped with a heavy synthetic rubber sole which is deeply cleated to afford maximum traction. The boot resembles the standard combat boot inasmuch as it also has a 5-inch cuff which is sufficiently high to fold in the trouser leg and is fastened with two straps and buckles.

The upper is composed of a chrome retan leather vamp, with the flesh side out. The quarters, cuff, and tongue are made of olive-drab nylon. A new feature is the addition of a small screened eyelet, placed on the inside of the shank area, to permit water to drain from the shoe while it is being worn.

ANTIEXPOSURE SUIT FOR AIRMEN

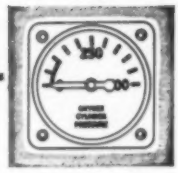
Technicians of the personal equipment laboratory of the Air Technical Service Command headquarters have developed a new antiexposure suit for airmen who may be forced to "ditch" their plane at sea, particularly in cold weather.

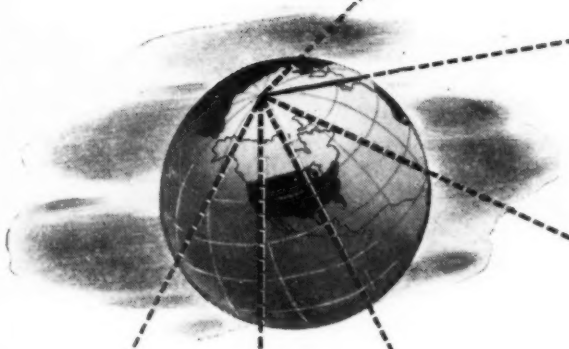
They gave it a severe test recently, chopping through a foot of ice and then proceeding to "dunk" a couple of technicians, garbed in the new suit, in the freezing water. For an hour, encased in the protective cloth of the suit which covers everything but the face, two officers of the laboratory's clothing branch lay in the water.

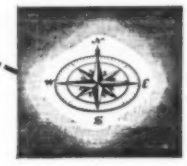
Thermocouples attached to the suits recorded the temperatures of the two officers during the test, throughout which no part of their anatomies registered lower than a few degrees of normal. The antiexposure suit is made of nylon coated with a substance rendering it both watertight and airtight.

NEW SEAPLANE CARRIES 750 MEN

The Hughes Aircraft Company has lifted the wraps slightly on its "world's largest plane," revealing that it could carry 750 soldiers and their equipment. It is a seaplane with a wingspread of more than 300 feet and a hull 220 feet long. It will carry 40 tons, or 14,000 gallons, of gasoline and a pay load of between 60 and 70 tons. The B-19, largest land plane, has a wingspread of 212 feet; the Martin Mars, largest seaplane in service, has a 200-foot wingspread. (*Continued on p. 214*)







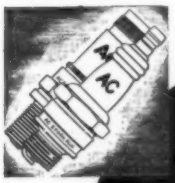
SUPPLIERS TO

United States – Britain – Russia

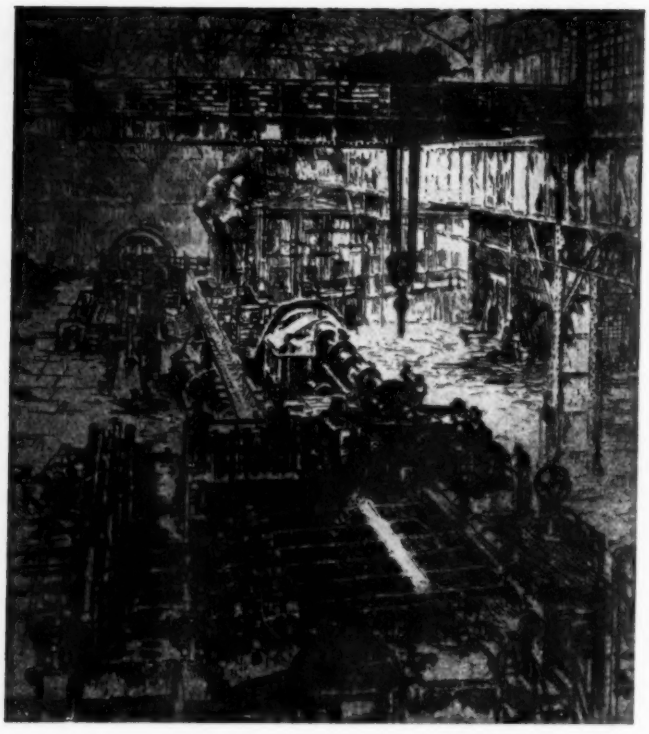
A great many of the more than 450 *kinds* of products which AC has been building for war are serving under many flags, —those of the United States, the British Commonwealth, the Union of Socialist Soviet Republics, and their Allies. The R.A.F. bombsight, Sperry automatic pilot, Browning .50 calibre machine gun, automotive spark plug, ceramic aircraft spark plug, tank panel and instruments, oil filter, and Diesel intake silencer are typical of the variety — and the importance — of these AC-built "weapons" of mechanized war.

Victory is our business. Therefore, we work to give the fighting men of the Allies the kind of product we know is best for that business, — the very finest product that we can make.

AC SPARK PLUG DIVISION • GENERAL MOTORS CORPORATION



• *Awarded to AC on September 2, 1942, and renewed four times, for outstanding achievement in producing for Victory.*



Aetna's two great plants are working night and day producing the tools for Victory

ARMY E NAVY

The AETNA-STANDARD ENGINEERING COMPANY

YOUNGSTOWN, OHIO, U.S.A.

ASSOCIATED COMPANIES

HEAD, WRIGHTSON & COMPANY, LIMITED, THORNABY-ON-TEES, ENGLAND

JOHN THOMPSON COMPANY, LIMITED, TORONTO, ONTARIO, CANADA

New Developments

WEAPON CASE FOR PARATROOPERS

A case in which paratroopers may carry the M1 rifle or any type of carbine or submachine gun has been developed by the Quartermaster Corps. The new case will replace the existing Army Air Forces' container which, however, will continue to be issued until the supply is exhausted and will render obsolete the former scabbard for the caliber .30 carbine. The case is constructed of olive-drab canvas and webbing, and is padded with felt to protect a parachutist in event he lands with the weapon beneath him.

COLORED SKYMARKER SMOKE BOMBS

The M87 colored streamer smoke bomb has been designed for use with precision instruments in bombing enemy targets through clouds, smoke screens, and other conditions preventing visual sighting. The "pathfinder" bomber of an allied formation, guided over the target by means of special instruments, drops one or more skymarker bombs.

While falling toward the enemy installation, the skymarker bomb leaves a bright trail of red or yellow smoke which persists for at least one minute and which is clearly visible to planes flying five miles to the rear. The succeeding waves of bombers drop their bombs at the point where the colored smoke breaks through the clouds, and their explosive and incendiary bombs follow the same course down to the target.

ELECTRONIC VULCANIZATION

Basic patents covering electronic vulcanization of rubber and other materials have been purchased by the B. F. Goodrich Company and the Firestone Tire & Rubber Company. The patents were originally granted on discoveries made by R. A. Dufour and H. A. Leduc of France and by E. E. W. Kassner of Switzerland. The rubber companies have stated that the patents would be made available both to the rubber and plastics industries on a reasonable basis, thus ultimately making available to consumers improved rubber and plastics products of various types at lower costs.

In electronic vulcanization, high-frequency oscillations shake the molecules of rubber and sulphur millions of times a second, creating uniform heat throughout the product being vulcanized in a fraction of the time required when steam is used. The same uniform heating removes difficulties in the molding of thick plastic products. Electronic heating also makes possible the use of simplified equipment.

WET FLASHLIGHT BATTERIES

A rechargeable wet flashlight battery for industrial use built on the principle of the automobile wet storage battery, especially valuable for operations where long-continued and steady usage of flashlights is necessary, has been developed by the B. F. Goodrich Company, Akron, Ohio.

New-type wet-cell batteries placed under test eighteen months ago are still giving excellent service, the company reports. It is claimed that the wet storage batteries are more economical than dry cells when flashlight service is required in volume or where batteries require replacements more than once every two weeks.

"MONSTER" BRIDGE BUILDER

Reconstruction of vital railroad bridges to speed allied supply lines through Germany was accelerated by the development of the "Monster"—a launching device that can place a giant steel beam into position within half the normal time. Constructed by Army Engineers for a rush bridging job on the Moselle, this space-spanning giant has launched six 100-foot meter beams in ninety minutes, a job that usually requires about three hours, and has lifted into place completely prefabricated bridge spans up to fifty feet in length. (*Continued on p. 216*)

TWO FINE SKEET GUNS...

FOR TRAINING AERIAL GUNNERS

FIGHTER PILOTS and aerial gunners of our armed forces are the finest "team" of wing shots in the world. Much of the credit for their marksmanship can be attributed to shooting clay birds during their basic training.

Remington is proud to have two fine skeet guns that are used in this training program. Shown here, on the right, is the Remington Sportsman, a 3-shot autoloading shotgun. Skeet shooters and aerial gunners like it because it points as naturally as your finger, and its fast, dependable action leaves only one thing to think about—breaking the target. On the left is the Remington Model 31, pump action, repeating shotgun. It is a naturally accurate pointing gun, ideal for clay bird shooting. Aerial gunnery students have named it "the pump gun with the 'ball-bearing' action," because of its velvety smooth operation.

Remington manufactures a complete line of equipment for clay bird shooting. Not only shotguns, but mechanical traps, famous Blue Rock targets, and dependable, Shur Shot shells. Clay bird shooters the world over rely on Remington because they know that "If It's Remington—It's Right!"

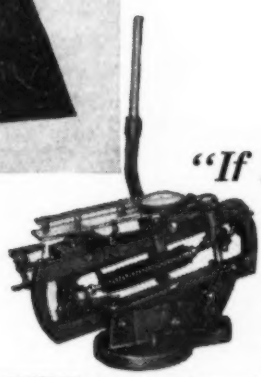
★ PAPER PACKS A WAR PUNCH—SAVE IT! ★

Remington

DUPONT

"If It's Remington—It's Right!"

The easy-breaking, easy-to-see BLUE ROCK target is America's standard clay target.

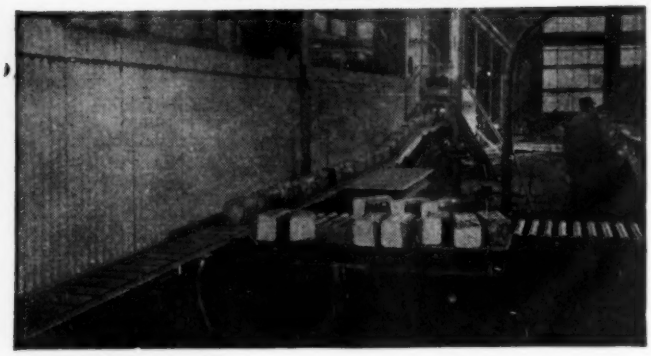


Remington "Shur Shot" shells. Known the world over for unexcelled target smashing performance.

The Remington "Wonder" Trap. The ideal trap for gunnery training purposes.

Sportsman, Blue Rock, Shur Shot and Wonder are Reg. U. S. Pat. Off. by Remington Arms Company, Inc., Bridgeport 2, Conn.

AN APRON FULL OF SHELLS FOR UNCLE SAM!



THIS Alvey-Ferguson *Apron* Conveyor installation carries billets from shearing machine to the furnace, where they are turned into rough forgings ready to be machined into shells.

Ruggedly built to withstand terrific wear, the aprons are made of channel carried on roller chains, with a cover angle over the top of the chains so that the top of the channel and the angle iron frame are flush. This makes it easy to slide the billets over the cover angle onto the channel aprons of the apron conveyor.

At various stages of production the conveyor carries the billets at elevations most convenient to the operators of the furnace, and various forging machines.

Whatever *your* material handling or product movement problem we can solve it with an A-F conveyor installation. Write, wire or phone, without obligation on your part for a consultation.

THE ALVEY-FERGUSON COMPANY
93 Disney Street CINCINNATI 9, OHIO
Offices in Principal Cities

Affiliated Corporation
THE ALVEY-FERGUSON COMPANY OF CALIFORNIA
P. O. Box 396, Vernon Branch, Los Angeles 11, California

CONVEYING EQUIPMENT
Alvey-Ferguson
METAL PRODUCTS CLEANING & FINISHING EQUIPMENT

New Developments

SPOKEN MESSAGES BY FILM

Recent improvements in sound recording, sponsored by the U. S. Army Signal Corps, have made it possible to compress long messages spoken into a recording device and reproduced on a thin film belt into such small compass that they can be carried in capsules harnessed to the backs of homing pigeons. About twenty times as much wordage can be set down in this manner as can be typed on paper of similar surface space. It is estimated that approximately 18,000 words can be put on one film belt. It is possible to insert two such film belts into a 4-inch capsule such as has been developed for carrier pigeons so that a single bird can carry 36,000 words of spoken message.

FLYING WEATHER BY PSYCHROMETER

An accurate instrument known as an aircraft psychrometer, for measuring temperature and humidity while an airplane is in flight, has been developed by the Meteorological Branch of Camp Evans Signal Laboratory. This instrument is now in active use on B-17, B-24, and B-25 bombers in many zones of operation as calibration equipment for aërograph instruments.

The aircraft psychrometer has also been mounted on many types of aircraft for a variety of special research projects where accurate data on humidity and temperature are required. Operational plans of the Army Air Forces have been substantially aided and air campaigns furthered by weather reports obtained with the assistance of this device in regions which are inaccessible except by airplane.

FACE MASK FOR BAZOOKAMEN

A mask, designed to protect the eyes and faces of bazooka teams, has been developed by the Quartermaster in coöperation with the Infantry Board. An adaptation of goggles, the mask, known as M1943, has a skirt of vinyl resin-coated cloth which extends around the face and side of the head, giving full protection from particles blown backward after a rocket has left the muzzle of the bazooka. Lenses of the goggles are constructed of clear cellulose acetate 0.033 of an inch thick, and the mask is held in position by an easily adjusted strap of elastic webbing.

ORDNANCE-MEDICAL TRUCK

Many badly wounded soldiers who could not survive the average evacuation time of five hours to a field hospital are saved by the use of a surgical operating truck which the Ordnance Department supplies the Medical Corps. The truck is stationed immediately behind the areas of heaviest fighting to handle certain types of operations. It is equipped by the Surgeon General's Office with an operating lamp, sterilizer, hot-water tank, sink, adjustable lamps, and instrument cabinets. Besides their use on the battlefield, these "mobile operating rooms" were stationed at the docks in England on D-day to receive patients rushed across the Channel from Normandy.

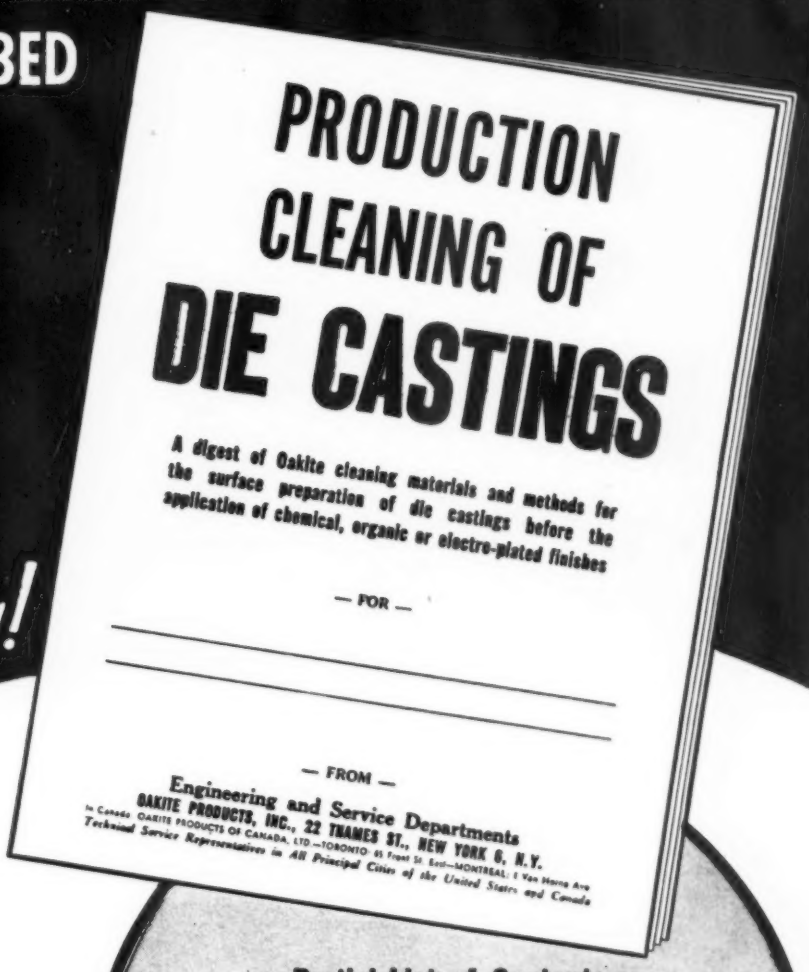
HIGH-ALTITUDE WIND TUNNEL

Containing the most highly flexible range of testing conditions in the country and capable of testing airplanes in the "fast-as-sound range," a new $2,500,000 variable-density wind tunnel at the Curtiss-Wright Corporation plant will soon go into operation. The tunnel will be capable of testing airplanes at pressure conditions comparable to those found at 35,000 feet.

TUNGSTEN CARBIDE PROJECTILES

The hardest material made by man was in recent months placed in the projectiles aimed at the new German Panther and Tiger tanks. Thereafter tanks were sometimes stopped with a single shot at ranges up to 3,000 yards. That material is tungsten carbide, and it is probable that it will be adapted to war against Japan. (*Continued on p. 218*)

PROFIT BY THE TESTED SURFACE PREPARATION METHODS DESCRIBED


PRODUCTION
CLEANING OF
DIE CASTINGS
A digest of Oakite cleaning materials and methods for the surface preparation of die castings before the application of chemical, organic or electro-plated finishes
— FOR —
— FROM —
Engineering and Service Departments
OAKITE PRODUCTS, INC., 22 THAMES ST., NEW YORK 6, N.Y.
In Canada: OAKITE PRODUCTS OF CANADA, LTD.—TORONTO: 45 Front St. East—MONTREAL: 1 Van Horne Ave
Technical Service Representatives in All Principal Cities of the United States and Canada

FREE *for the asking!*

A practical, valuable guide to successful low-cost finishing of die cast alloys

In applying organic, electro-plated or chemical finishes to die castings for protective purposes, wear, appearance or sales apeal, experience shows that the results obtained are importantly dependent on the thoroughness and correctness of the preliminary surface preparation.

That is why the many plant-tested Oakite cleaning methods described in this new Oakite Digest can prove helpful to you. All are based on successful use by leading producers and users of all types of die cast alloys. All are helping to lower production cost and improve finishing results. Send for a FREE copy of this informative Digest today. It's yours for the asking.

Partial List of Contents

- Cleaning aluminum die castings before organic finishing
- Alkaline and solvent methods
- Stripping anodizing film
- Cleaning zinc die castings for chemical and plated finishes
- Cleaning before dichromating
- Cleaning before Bonderizing
- Electro and mechanical cleaning methods on magnesium die castings
- Cleaning antimonial lead alloy castings
- Cleaning brass, bronze and copper alloy castings
- Cleaning tin alloys, Brittania metal, white metal
- Cleaning die casting machines, steel dies
- Stripping black finishes from non-ferrous die castings

OAKITE PRODUCTS, INC., 24 THAMES STREET, NEW YORK 6, N. Y.

Technical Service Representatives Located in All Principal Cities of the United States and Canada

To Properly Clean and Condition For Durable Paint Finish Use

DEOXIDINE

The new Superbazooka fires a 38-pound 4.5-inch rocket having the destructive effect of a 105-mm. high-explosive artillery shell. Launcher and rocket can be carried by one man.

Official U. S. Signal Corps Photo

Much Army ordnance and equipment of steel are simultaneously cleaned and conditioned with 210 DEOXIDINE before receiving the protective paint finish.

210 DEOXIDINE was developed by the American Chemical Paint Company to do, and do better, many cleaning operations for which alkalies have been used. In spite of the fact that 210 DEOXIDINE is acidic, it removes most oils and soil quickly, effectively and economically and when properly rinsed leaves the clean metal free from those paint-removing, bond-destroying residues that impair the life and protection of paint coats.

210 DEOXIDINE meets army specifications —AXS 1245—for cleaning and conditioning for finish when used as directed in ACP Technical Service Data Sheets No. 3-2-210-2 and No. 3-2-210-4.

The American Chemical Paint Co. Technical Department will gladly consult with you and advise regarding proper chemicals to use in metal cleaning both for war products and those for civilian use—address Dept. H-5.

Manufacturers of Inhibitors & Metal Working Chemicals

AMERICAN CHEMICAL PAINT CO.

AMBLER ACP PENNA.

Note: West Coast Plants may address inquiries and orders for prompt delivery to: Leon Finch, Ltd., 728 East 59th St., Los Angeles, Calif.

New Developments

We could not afford to shoot away our tungsten carbide in the early stages of the war. We needed to conserve it for cutting tools. But recently we have been using it as the bullet core of a novel 76-mm. projectile. The housing is mainly aluminum, the total projectile weighing nine pounds as against fifteen pounds for the conventional shell. The muzzle velocity is 3,400 feet a second. The extreme hardness of the carbide core prevents its being flattened out on impact. Being both vastly harder and heavier than armor plate, it penetrates the plate far easier than could a steel core.

THE NAVY'S HELLDIVER

Curtiss-Wright's new Helldiver SB2C4 participated in the carrier-based air strikes on Tokyo in conjunction with the Iwo invasion with one of the greatest loads of explosives ever carried by a single-engined aircraft. The Navy and Curtiss-Wright disclosed that more than 2,000 pounds of bombs were carried by the plane, and in addition 20-mm. cannon are mounted in each wing, plus eight 5-inch rockets also in wing mounts. Belly carriers hold 1,000 pounds of bombs—wing racks another 1,000.

Called the best in the Navy, the plane dives more accurately since installation of "swiss cheese" perforated diving brakes. It also has a more powerful engine than previous models and a 4-bladed electric propeller instead of the original 3-blade design.

INVISIBLE DYE AIDS INSPECTION

With the Japanese war being fought on an ever greater scale, U. S. Army Signal Corps laboratories have been spurred to new research in scientific tropicalization, and a recent development is the use of an invisible fluorescent dye to facilitate inspection of treated equipment.

This dye is mixed with the lacquer which is sprayed over radios, field telephones, and other communications equipment to prevent the inroads of fungus and moisture—its chemical composition varying according to the particular lacquer used.

A special lamp, strong in its emission of ultraviolet rays and equipped also with a deep purple filter is directed upon the equipment, picks up the ultraviolet dye in the lacquer (though it is quite invisible to the eye), and shows with perfect clarity any imperfections in the spraying.

HAND GRENADE CARRIER

A new 3-pocket carrier for hand grenades has recently been developed by the Quartermaster Corps. The grenade carrier is made of No. 10 olive-drab hard-texture duck with three pockets in a vertical line, each fastening with two bronze-finish brass snap fasteners. It is attached to a soldier's cartridge belt with a bronze-finish brass hook. The three pockets are large enough to carry six "pineapple-type" grenades, three large-size explosive grenades, or three smoke grenades.

NONCOMBUSTIBLE RUBBER

Neoprene is the only synthetic rubber that does not support combustion. It is used for flame-resistant jackets on electric wires and cables aboard ships.

A NEW ARMY RADIO

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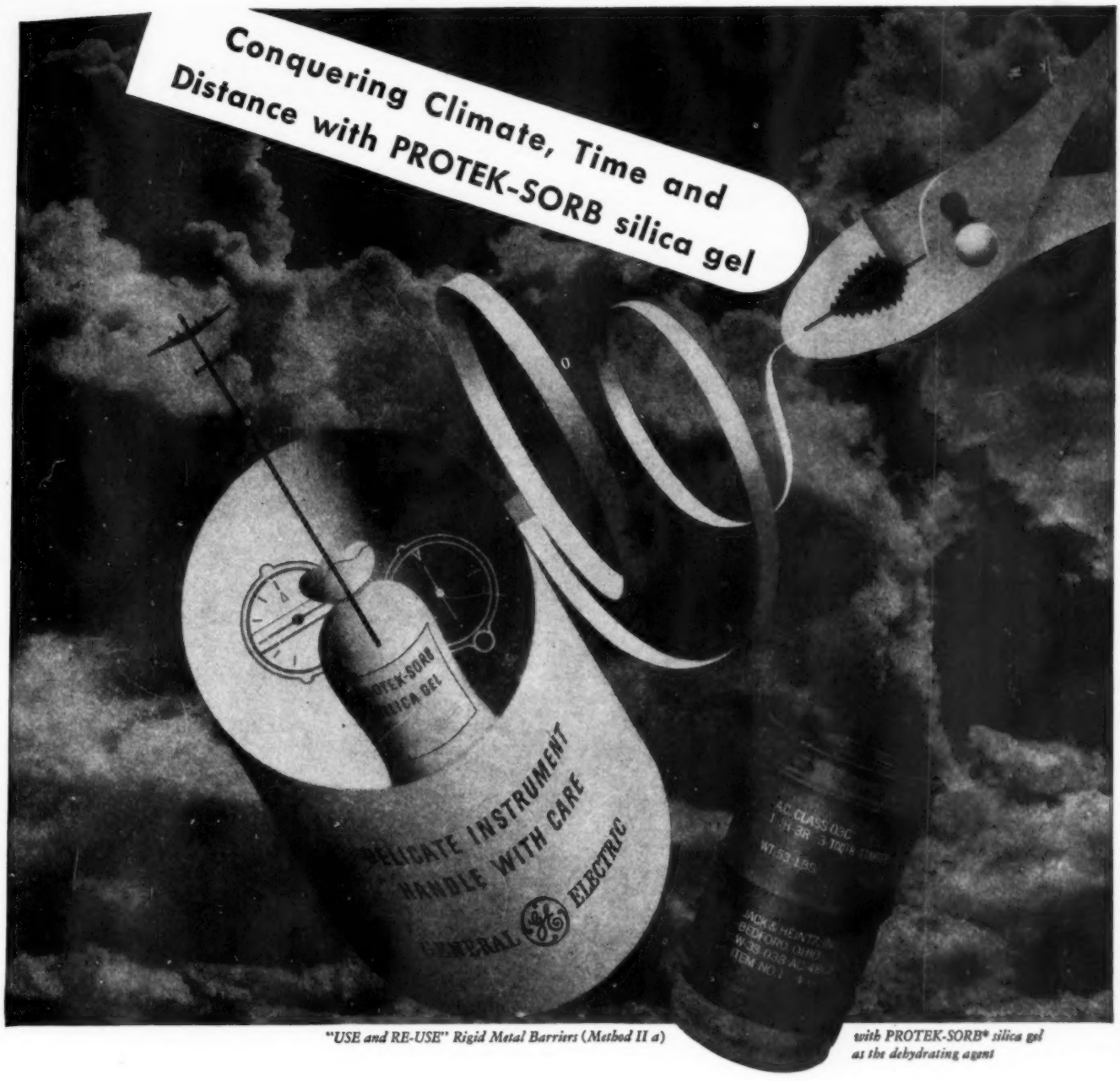
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THE ORDNANCE RESERVE CORPS

THE EDITOR.—Col. Crosby Field has opened a subject in the May-June 1945 issue that deserves development ("Can the Reserve Corps Survive?" p. 414). Congress acted after the last war to set up a Reserve Corps which, though we now know was very defective, was better than we had ever had before. Certainly after this war Congress should want to revise the Act of 1920 and give the country a better law based on what we have learned. Since the mobilization of the mechanical industries and the preparation of Reserve officers of technical ability will need to be at the forefront of future military preparation, I would like to see the Army Ordnance Association organize to prepare material that would be useful when the time comes after the defeat of Japan.

I agree with Colonel Field that most Reserve officers who gave their time over a period of twenty years before 1940, when it was not popular to talk preparedness, got at most very mediocre treatment. But looking at the matter philosophically I cannot feel too disturbed, because I see that through the years the Reserve officers have left their mark. I believe that in the periods of annual training and in the work at the district offices we gave the Regular officers perhaps as much as they gave us.

I know that there are Regular officers who will say that we gave them more. I could name a string of officers with eagles and stars on their shoulders who got their real fundamental training in industrial preparedness, and their industrial contacts, through working with the Reserve officers. I feel that if we Reserve officers above the age of 50 had not been called to uniform at all during the present war we still would have served the purpose of the National Defense Act.

But the Act of 1920 was defective in view of our present knowledge. In 1928 I submitted a report during a course at the Army Industrial College which pointed out some of the things which would, and did, happen in 1940 and 1941 when the Regulars were unable to call in Reserve officers who were necessary to put the plans into operation but who had ranks higher than any of the Regulars assigned to the work.

Thus, many of the men who represented the Army at the beginning of the war, or rather at that critical period from July 1940 to December 1941, were inexperienced in dealing with industry. When presidents of corporations came to Washington in those days they often had to deal through young officers who had held minor positions in their own factories, and they were righteously indignant about it. One industrialist told me that the "labor expert" he had to deal with had been a salesman in his city. Later, when older Reserve officers were called into the service, the jobs were filled, and I have seen Reserve officers who were paid $30,000 a year in civilian life placed on work that any corporal could do.

But I am not disposed to blame the Regular officers for these conditions. I agree with Colonel Field that we need fundamental changes in the setup of the Reserve Corps. I do not agree, however, that Reserve officers above the age of 40 should be placed on the inactive list. A glance over the roster of industry will show that most of the big jobs are held by men above the age of 50. At that age and above, these men can take Reserve commissions in time of war because they are usually independent of financial worries and their families are grown. These are the men who could serve in many positions in Washington, in district offices, and in factories instead of the young men who should have been serving in the field. (*Continued on p. 222*)

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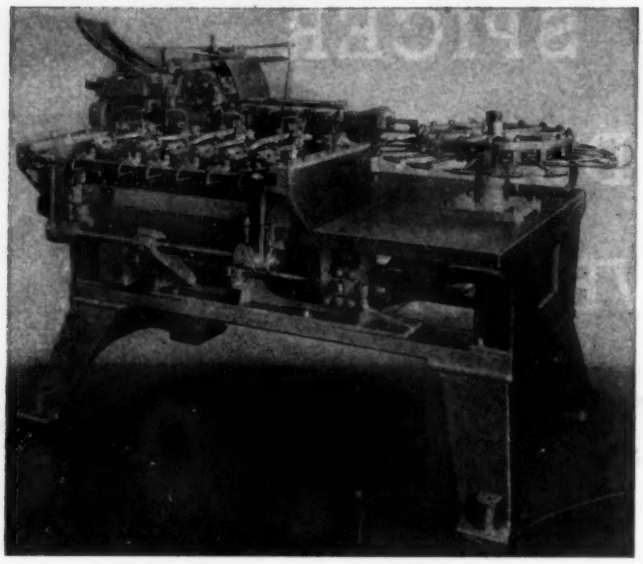

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But this would require a provision in the Defense Act that would permit these men to be brought into the Army at the early prewar preparation stage at ranks fitting their capacity. This would require that the Regulars holding inferior ranks at the time would be given a higher brevet rank, or specialist ranks should be created for civilian officers on technical work but not trained in military operations.

GEORGE S. BRADY
Colonel, Ordnance Reserve.

THE EDITOR.—Col. Crosby Field is to be congratulated on his restrained and impersonal approach to the question "Can the Reserve Corps Survive?" His article is timely because now is the time not only to plan cures but to take the remedial actions that are so obviously needed.

The question of the survival of the Ordnance Reserve Corps is rapidly becoming an academic one. There cannot be even the nucleus of such a corps without the participation of the temporary officers now in service. I think the majority of these officers want no part of such an organization. The only ones who could be attracted, it seems to me, are the younger officers under draft age who can thereby protect their military position.

The cause for apprehension regarding a revival of the Reserve Corps is based on the handling during this war of three aspects of the personnel problem; namely, assignment, promotion, and recognition. The performance of the Ordnance Department in these three important matters has, it is generally admitted, been distinguished only in a negative way. It is not my intention to dwell on past mistakes except to use them as signposts toward a better way. This is no time—if there ever is one—for recrimination.

Promotion policy in the early days of the war seemed lacking in plan and principle. To be near headquarters and to have served the minimum required time in grade without having committed any cardinal errors seemed the criterion. Following that policy came the pernicious "Table of Organization" method which just about discarded merit as a basis for promotion and emphasized the fortuitous circumstances of assignment and location. If you were serving with an outfit that had a large and juicy T/O, chances were good; but if you were in an out-of-the-way unit with a lean T/O, you could count on an accumulation of verdigris on your bars rivaling the patina of Sherman's horse on the Plaza!

What is now required, if it is not too late—and I do not think it is—is branch promotion with an evaluation of the promotee's capability and record. Branch, or in this case departmental promotion, will throw the few remaining and occurring vacancies open to worthy souls anywhere in the Ordnance Department. It is important that the system be applied to the whole Department and not be confined to a subdivision. Otherwise, there is little improvement over the T/O policy. The evaluation of an officer is similar to the Army's adjusted service rating, and it is understood that it has been adopted or soon will be adopted in one major division of the Ordnance Department.

Consideration is given to such factors as total length of service, length of active service, overseas service, time in grade, civilian occupation and responsibilities, age and efficiency rating. Each factor should be weighed, announced, and adhered to with no expedient changes *in camera*. Then the forgotten captain or lieutenant can content his soul knowing that when his number comes up he will get his reward.

Misassignments, or in Army terminology, malassignments, are bound to occur in a citizens' army. Every one cannot do what he feels best qualified to do or what he did in civilian life because the jobs in the Army naturally differ from the jobs of industry and business. But there have been hundreds and perhaps thousands of cases of serious misassignments which, in fairness to

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the incumbent and to the Government, should have been remedied.

Some of the cases are fantastic, and the temptation to cite one classic example cannot be resisted. That is the case of the paint salesman who was made an expert on tank armor because, forsooth, both paint and armor are "protective coatings." It speaks well for the versatility of these misassigned officers that, on the whole, they have accepted their lot philosophically and are doing jobs for which they were not trained or experienced in a more than satisfactory manner.

The remedy for misassignment is simple and practicable. If an officer is still misassigned at this late date he should either be assigned to a job he is fitted for or relieved from active service at his request. In determining whether an officer is misassigned, his own testimony and consideration of his civilian occupation constitute the best and almost irrefutable evidence. But, some one cavils, who is to replace him? Again the answer is simple. Either the vacancy does not need to be filled at this juncture or the file closer, his understudy, takes over.

Recognition, the last of the three thorns, does not mean the indiscriminate awarding of medals. No officer, unless he be on the lunatic fringe that Colonel Field refers to, expects Distinguished Service Medals and Legion of Merit awards to be passed out with the rations, but he can reasonably expect that the Army can afford him recognition at least equal to that granted in civilian life and by the Army to civilians.

THE War Department is empowered to grant "citations, insignia, emblems, medals, and devices" to civilian employees and has been lavish in their distribution, particularly of the Civilian Service Ribbon which is awarded to any civilian employee whose record has been "satisfactory" for six months. Far from suggesting such a system be employed by the Army, it is believed that it would be odious to most soldiers. However the fact remains that many a soldier who has served with a rating of "excellent" has nothing to point to with pride, not even a creased and worn piece of paper he can read and console himself with.

Likewise, the "Industry-Ordnance team" has been highly and justly praised but with the emphasis noticeably on the industry end, despite the fact that industry, the triple-threat fullback and Ordnance, the blocking guard, are blood brothers.

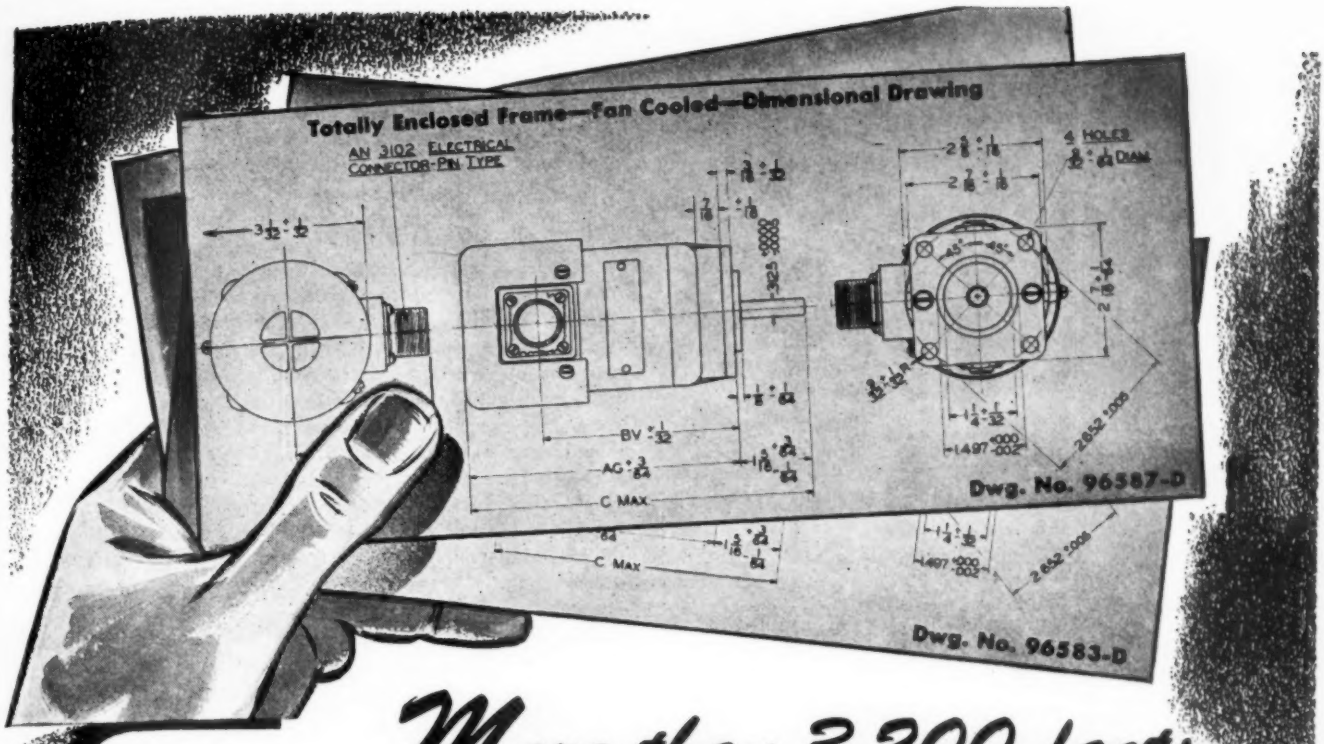
Commendation is an effective and cheap method of recognition and reward. It has been too little used, perhaps because of the old Army precept that a soldier is expected to perform any duty well. Another reason advanced is that to commend a good organization or individual is discouraging to those not commended. So uniformity is obtained by having every one discouraged!

And it is discouraging to be part of an organization that is performing day in and day out in an exemplary fashion with an occasional outstanding job thrown in for good measure, with never a kind word. It is something more than discouraging when some other outfit is publicly commended for what yours has done or a commendation from higher echelons is deliberately held up to rest in limbo.

It is understood that in the Navy the immediate commanding officer is authorized to issue a letter of commendation, which entitles the recipient to wear a commendation ribbon. The senior service might well adopt this.

The form of recognition most appreciated by an officer is, after all, promotion. Why not, then, recognize deserving officers who have not had at least one promotion by promoting them on their relief from active duty? It costs the Government nothing, there is plenty of precedent for the practice both in the Regular Army and the Officers' Reserve Corps (after the last war), and it would salve the injured pride and build up the spirit of the home-bound Cincinnatus.

The title question "Can the Reserve Corps Survive?" suggests a corollary "Is an Ordnance Officers' Reserve Corps Necessary



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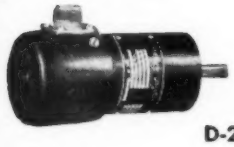

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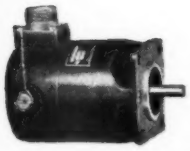

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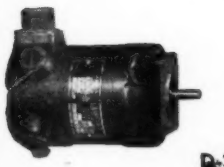

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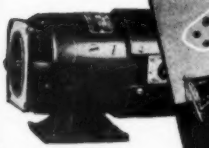

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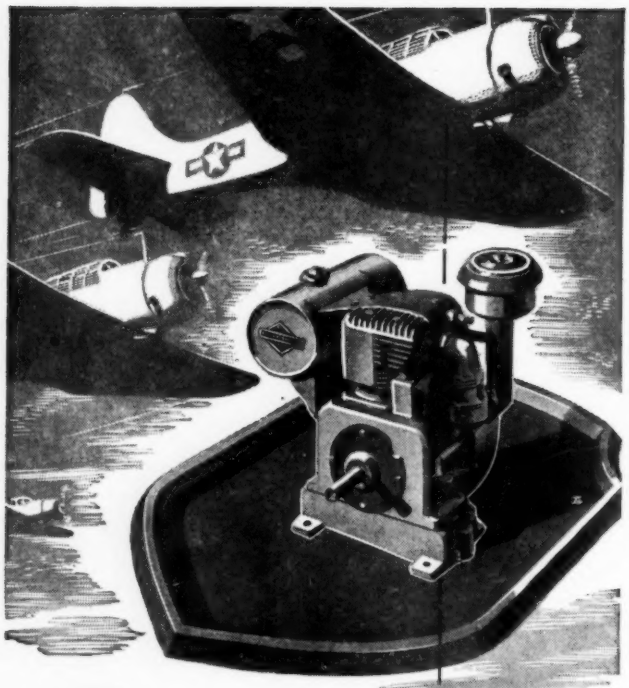

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or Desirable?" It is freely and thankfully admitted by military authorities that mobilization of our Army could not have been accomplished in 1940 and 1941 without the Officers' Reserve Corps, derisively referred to in prewar days as the "phantom army." It follows logically, therefore, that without the Officers' Reserve Corps the war would certainly have been lengthened and might have ended in defeat before it was yet begun.

But whether the Ordnance Reserve was essential to the proper functioning of the Ordnance Department is a moot question. The writer, having been dragooned into the Ordnance Reserve from a combatant branch of the service at a late date, is not in position to speak knowingly. It is his opinion, however, that the Ordnance district system, which was the basis for all ordnance procurement and expansion and which has been highly praised, was almost entirely the product and the effort of Reserve officers working steadfastly and unappreciated through the peaceful years, when there was going to be no more war. This single issue of the Ordnance Reserve cannot be discounted and may well constitute a justification for the continued existence of that Reserve.

BUT the duties of an Ordnance officer in time of war correspond, in theory at least, with his peacetime occupation, and, far from being an advantage, his commission may be a distinct detriment to him. He works usually with civilians and is differentiated from them mainly by his uniform, his pay, and the fact that he has blindly subordinated himself and is no longer a free agent.

At one Ordnance plant laborers got more money than the base pay of a second lieutenant, and the highest paid per-diem employee got more than the colonel. In addition, putting a uniform on a man does not make a soldier of him but does cause him embarrassment when he must fill military rôles.

Civilians realize this and are quick to remark "desk soldier" or "draft dodger" when, if the same man were doing the same job in civilian clothes it would be considered quite praiseworthy and he would be termed a "defense worker," an honorable title meriting such perquisites as tires and "C" cards. So in many, if not most, cases the man would be more effective and of more value to the country in civilian clothes than as a Reserve officer.

If this be proved the case, it is suggested that a possible solution of the problem might be to have the Army Ordnance Association constitute itself a cadre of trained and experienced civilians which would be drawn on by the Ordnance Department in time of need. They would then serve as civilians in a civilian organization, such as the War Production Board, on a loan basis. From the individual's point of view this should be much more satisfactory. He would suffer no loss of income, his family would not be subjected to great inconveniences, he would maintain his standing in his profession, his career would not be disorganized, he could not be misassigned except with his acquiescence, and, finally, he would not have to submit to indignities at the hands of incompetents. And he could always quit.

A further suggestion (not original) is that there be appointed from the membership of the Army Ordnance Association a committee to study these questions. This committee should consist of civilian members with no past or present military service, Officer Reserve Corps members, AUS (commissioned from civil life) members, and Regular Army members. The last category should act in an advisory capacity only. This is for their own protection for, no matter how they vote, they will be accused of ulterior motives by those who cannot or will not recognize that most Regulars have been the Reserve Officers' best friends.

CHARLES MCKNIGHT,
Colonel, Ordnance Department.

ARMY ORDNANCE

THE JOURNAL OF THE ARMY ORDNANCE ASSOCIATION

Founded 1920

For Victory through Armament Research, Production, and Supply

CONTENTS

The New 75-mm. Gun M20 . Frontispiece
Victory . . . . . 228 A
AN EDITORIAL
Naval Ordnance 229
The Ordnance Record in Europe . . 230
Recoilless Rifles 232
COL. RENÉ R. STUDLER
Recoil Elimination 236
MAJ. L. B. HEDGE
The Ribbon-Frame Camera . . . 238
C. N. HICKMAN
Ordnance Wind Tunnel (Pictorial) . 240
Radar—Past, Present, Future . . . 241
GORDON FERRIE HULL, JR.
Rockets for Aircraft 244
LOUIS BRUCHISS
Decorations of the Army (Pictorial) . 246
The Earthquake Bomb 248
COL. HARRY SCULLIN AND COL. CLYDE H. MORGAN
The Shooting Star 250
TONY LEVIER
Ordnance Roll of Honor 252
Gun Design 254
LIEUT. COL. G. L. COX
The Atomic Bomb 257
Industry-Ordnance Leaders (Pictorial) 258
Training Enlisted Specialists . . . 260
CAPT. J. G. SMITHWICK
Oran to Naples 262
CAPT. WILLIAM G. MEADE
Month by Month 265
Britain's Bridgelaying Tanks (Pictorial) 268
Association Affairs 269
Professional Digest 280
Automotive Maintenance 292
Machine Guns 294
From the Record 302
Ordnance in Review 306
Book Reviews 312
Index of Advertisements 323

We announce with pleasure and pride the forthcoming publication of LOGISTICS —devoted to the proposition that America must be kept strong ashore, afloat, and aloft. This latest of the Association's publications will make its appearance shortly. It will be sent to all members of the Association without additional cost.

LOGISTICS will be under the editorship of Col. James L. Walsh, founder and first editor of ARMY ORDNANCE magazine, who has graciously volunteered his services. Dr. John J. O'Connor, now on the staff of Lieut. Gen. L. H. Campbell, Jr., Chief of Ordnance, will serve as managing editor. From its modest beginnings, LOGISTICS will branch out into broad fields and will serve as a forum dedicated to the effective utilization of our national resources for peace and security.

LOGISTICS will complete the "Big Four" of Army Ordnance Association publications. Here they are: (1) ARMY ORDNANCE, founded July 1919, a review of industrial preparedness for national defense. It has won its spurs through more than a quarter-century of service to our armed forces, to industry, and to the Nation. (2) ARMY ORDNANCE BULLETIN, founded June 1940, a monthly newsletter from Washington containing current information of interest to members of the Industry-Ordnance team. (3) FIREPOWER, founded June 1944, the Ordnanceman's journal, now one of the most popular publications among GI Joes. (4) LOGISTICS, the baby of the family with a big job to do. Depending on how well that job is done rests a great deal of our future security.

Which goes to show that when Ordnancemen attack a problem they go after it from all four sides!

—*The Editors*

Vol. XXIX **SEPTEMBER-OCTOBER, 1945** **No. 152**

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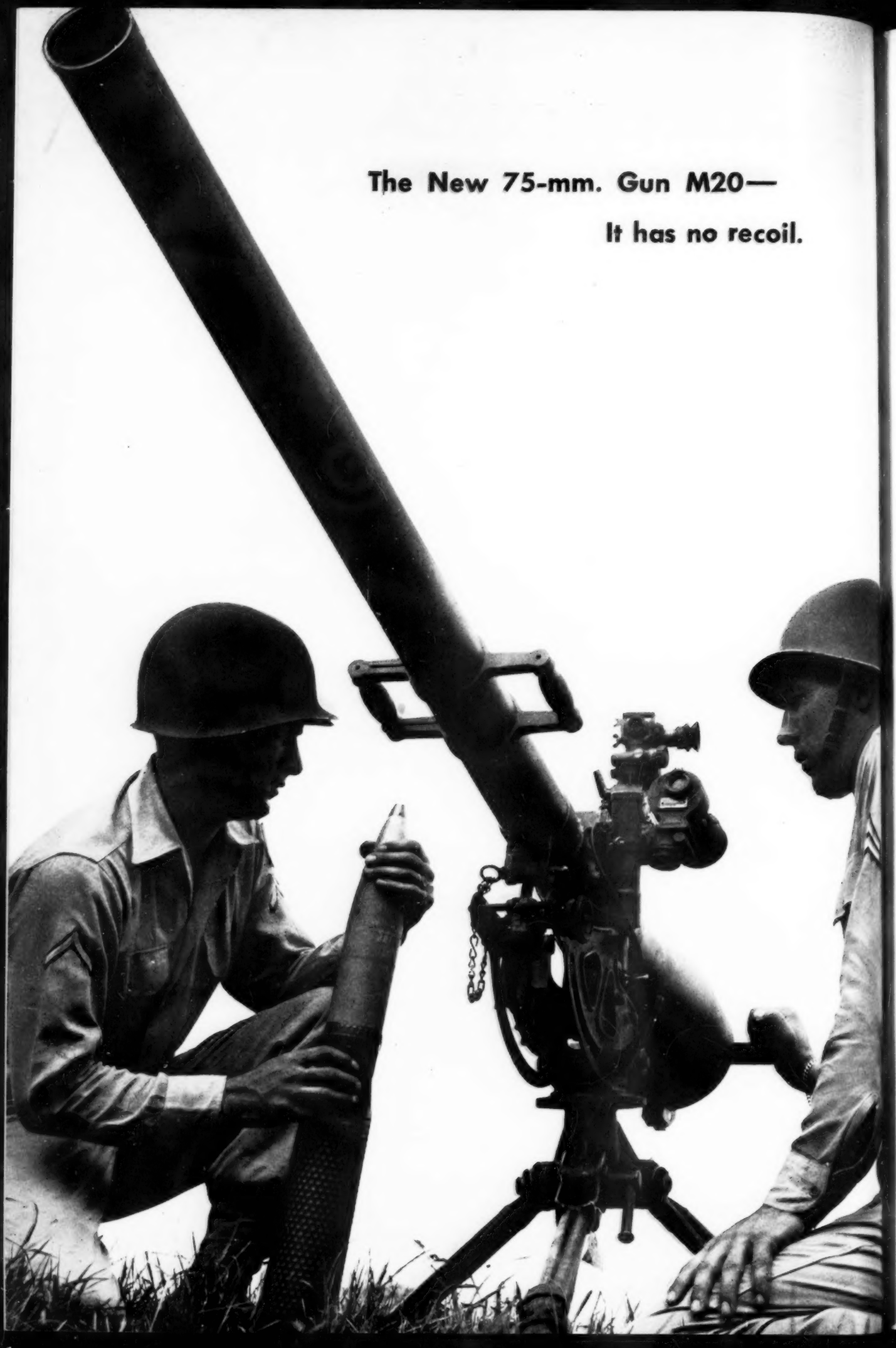
The New 75-mm. Gun M20—
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Victory

An Editorial

OUR VICTORY over the Japs coming quickly upon the defeat of Germany is the culmination of the bitterest war in all history. With indomitable courage, superb military and naval leadership, superior weapons in profusion, and the sustaining power of Divine Providence, we have fought and won a just war. As the murderous attack on Pearl Harbor was shocking, so now its vindication is sweet. We have conquered a wicked, bloodthirsty military power.

¶ To call the rôle of those whose leadership in this vast operation has made victory possible is difficult. America will always remember her honored dead. To the heroic Marines and Infantrymen who got the toe holds on distant islands, the valiant Navy which carried the bombardment from gun turret and carrier-based craft to the Japanese mainland, to the intrepid fliers who braved the distances of the Pacific, to American industry and to those at home who so loyally supported these great military operations a grateful nation now gives thanks.

¶ But this war will be a double tragedy if we fail to learn its many stark lessons. Of them all the greatest lesson is this: We must be vigilant, we must be prepared! The San Francisco Charter is a great document, its purposes for peace must be upheld at all times. But over and above it stands Preparedness. Let us all vow that never again shall one American life be sacrificed to unpreparedness. Ours should be the philosophy of General George Washington that we will ever maintain a posture of readiness. With malice toward none let us bind up the wounds of war but let us also keep America strong for our national security and peace. To that high purpose the Army Ordnance Association dedicates all its energies. It calls upon all Americans of good will to do likewise.

THE capitulation of Japan came after this issue of ARMY ORDNANCE *had gone to press. The editorial on the preceding page was written subsequently to express the feelings which are uppermost in our hearts now that victory is won. While the editorial on p. 267, "The War against Japan," is no longer timely, its sentiment holds for all those who, forgetful of Pearl Harbor, dare to molest the future peace and security of the United States of America.*

Naval Ordnance

The Fleet's 85,600 Guns Now Speak with Authority

EACH phase of the war has brought changes in naval combat conditions which Navy Ordnance has had to meet. There was a time, for instance, when the 16-inch guns of battleships were rarely fired, although undoubtedly their existence made the enemy more respectful. The guns that were kept busy in the early part of the war were the antiaircraft guns, the guns that fought off the enemy's air attacks on our expanding seapower.

The Navy's most powerful guns on the new battleships weigh one hundred tons; they fire projectiles that weigh a ton and travel almost half a mile a second to a distance up to twenty-five miles. While under way, the new ships can hit a moving target with phenomenal accuracy. These are the ships and guns which took naval firepower to the doorstep of Japan and unloaded it on her war industries.

The ships of the Fleet today mount 85,600 guns of all sizes, from 20-mm. to 16-inch, weighing from 100 pounds to 100 tons each. Their mounts range from a slender pedestal of 300 pounds to an armored 3-gun 16-inch turret weighing as much as a whole destroyer.

The Navy uses projectiles of all types —armor-piercing, antiaircraft, incendiary, illuminating, and shore-bombardment. Naval ordnance includes hoists and rammers to bring the ammunition from the shell rooms and magazines and load it into the guns, in addition to range finders, computing instruments, transmitting and receiving instruments, and gun directors for directing the gunfire accurately to the target. It also includes heavy armor, some of it thicker than the diameter of the 16-inch shell it must keep out; torpedoes for destroyers, cruisers, PT boats, submarines, and airplanes; rockets and rocket launchers; bombs and bombsights; mines of various types; depth charges and their projectors; demolition material for underwater obstacle clearance; nets and booms for protecting naval anchorages; flares and other pyrotechnics.

The job the Bureau of Ordnance has had to do since the beginning of the war has been staggering. Newly constructed warships had to be equipped with guns and mounts almost overnight. Now our ships are well supplied with original installations of guns and other nonexpendable ordnance. In addition to our fighting Fleet itself, more than 6,000 merchantmen have been provided with Navy guns. Now the big jobs are repair and maintenance of the guns and mounts we have, adding to our ships new and improved weapons and control devices resulting from continuous research, and providing the ammunition for which requirements are constantly increasing.

In 1942 the Navy averaged $29,210,411 a month for all types of ammunition. This year when production reaches its peak the Navy will be turning out each month about $240,000,000 worth of ammunition. Roughly, a third of this will be rockets, another third gun ammunition, and the rest will include torpedoes, bombs, depth charges, mines, pyrotechnics, and other ordnance. Tremendous quantities of ammunition are being expended by the Navy and will continue to be expended in ever-increasing quantities. The modern warship can throw 10,000 pounds of antiaircraft projectiles into the air in 15 seconds of fire.

Figures from some of the major Pacific campaigns further indicate the vast quantities of ammunition needed. At Tarawa, the Navy used 3,000 tons of gun ammunition. The Marshalls took 16,000 tons. In the Marianas, Navy guns fired 36,000 tons before Tinian, Guam, and Saipan were taken. Little Iwo Jima was pounded with 16,000 tons. At Okinawa, almost 50,000 tons were fired.

Rear Adm. George F. Hussey, Jr., Chief of the Navy Bureau of Ordnance, feels that the most valuable lesson to be learned from this war is that technological and scientific research in ordnance must continue even in time of peace.

One of the most eloquent examples of the need for prewar ordnance readiness is antiaircraft defense. When appropriations were made in 1931 for the FARRAGUT-class destroyers, the first laid down since World War I, the 5-inch 38-caliber gun was designed for them. It is the best long-range antiaircraft weapon of the Navy. Furthermore, the U. S. Navy had it years before the Nation was forced into actual hostilities. There was plenty of time to prove its potentialities, to eliminate flaws, to incorporate new techniques of fire control, to prepare tooling facilities for its manufacture, and to train gunnery crews.

BUT the war already had started in Europe before we acquired a gun that could afford adequate close-in air defense and be produced in sufficient quantities to meet expanding demands. The present 40-mm. and 20-mm. are the best close-in antiaircraft guns in the world, but they were deadline developments that were turned out in amazing quantities just in time to curb the enemy's air threat to our Fleet. Naval Ordnance has done and is doing a great job for victory. We salute every man and woman in it and in industry. The Industry-Ordnance team is all inclusive.

LEADER of the Naval Ordnance forces is Rear Adm. George Frederick Hussey, Jr., native of Brookline, Mass., and Naval Academy graduate, Class of 1916. He symbolizes the close coöperation existing between our Army and Navy Ordnance organizations in the services and in industry.

An officer of long service with the Navy Bureau of Ordnance, its arsenals and proving grounds, Admiral Hussey was in command of a mine squadron in the Pacific on December 7, 1941. He arrived at Pearl Harbor December 9th, and was assigned to command the offshore patrol in the Fourteenth Naval District.

In April 1942 he returned to the Bureau at Washington to become director of its production division. In December of the following year he succeeded Rear Adm. H. P. Blandy as Chief of the Bureau of Ordnance.

The drawing on the front cover of this issue, which is dedicated to Navy Ordnance with admiration and affection, is the work of LeBarron Coakley.

The Ordnance Record in Europe

A Story of Service from Invasion to Victory

FROM the invasion of Normandy, June 1944, to the surrender of Germany, May 1945, U.S. Army Ordnance service played a major rôle in the smashing victory of our arms over the German war machine. The story is one of men and matériel, of supplying the world's best soldiers with the world's best equipment, and with the most of it as well. It is a story of keeping that equipment in the shape necessary to make our army a faster and harder-hitting force than the enemy's. From the very first day of the invasion, when 1,500 pounds of ordnance landed for every GI who hit the beach, the Ordnance achievement has been one of the greatest in the history of logistics.

The first phase of Ordnance service in the European Theater of Operations ended on D-day. For two years prior to that time we had been hoarding vast stock piles of weapons, ammunition, and vehicles. The task of preparing this equipment for the invasion and the Battle of Europe required 21 storage depots, 19 vehicle parks, 22 maintenance shops, and 8 ammunition depots in England alone. In 32 different plants we assembled 1,000 vehicles daily. For 2 years we worked on the 350,000 different items and parts which comprise ordnance equipment. It was an endless job of processing, assembling, waterproofing, inspecting, issuing, and replacing.

From America's factories, ordnance was coming to England at the rate of fourteen tons a minute, but it was not coming in any too quickly. Had it not been for the splendid efforts of American management and labor—the team that delivered the goods—the task of supplying our troops would have been almost impossible. For a picture of the job that faced us, let us look for a moment at some of the matériel requirements of the U. S. Army.

The table of basic allowances for an armored division requires 13,148 small-arms weapons, 499 artillery pieces, 879 combat vehicles, and 1,755 other vehicles. The total tonnage for these items is 23,317. The monthly replacements in such a division for tanks alone amount to 8,000 different kinds of parts and assemblies involving 1,500,000 individual pieces packed in 15,000 containers.

The initial equipment of an infantry division calls for 16,843 small-arms weapons, 280 artillery pieces, 17 combat vehicles, and 2,072 other vehicles, totaling 9,072 tons. An air-borne division requires 15,444 small-arms weapons, 110 artillery pieces, and 2,075 vehicles, a total of 8,448 tons.

Ammunition production is based on the formula of one ton per gun per day to support barrages like that of the Third Army's XX Corps which fired 1,000 tons during the 10-day assault on the fortress city of Metz. Because we have 23 fieldpieces for every 1,000 combat soldiers (as opposed to World War I when the ratio was 4 to 1,000) it was necessary to produce 1,496,000 tons of artillery ammunition between D-day and April 20, 1945.

To meet requirements like the above, we brought 2,000,000 tons of equipment into England before D-day, including 22,741 combat vehicles, 281,768 general- and special-purpose vehicles, 1,494,941 small-arms weapons, and 19,959 artillery pieces. Between that time and V-E Day, we supplied our own and allied troops with nearly 2,500,000 more tons, including units equipped in the United States.

But our work in England was merely preparatory, and after the initial landings in France a new phase of Ordnance service entered the picture. This was the job of supply in the field to meet the needs of our troops as they fought their way into France, Belgium, Luxembourg, and Germany. The task was one which required great ingenuity and resourcefulness. For several months we had only the beaches on which to land our equipment, and our communications with forward supply elements were insecure at best. Nevertheless, between June 6 and July 16, 1944, the matériel which we brought to France from base depots in England included 8,773 jeeps, 8,553 trucks (2½-ton), 212,000 tons of ammunition, and 64,292 tons of replacement parts.

After the break-through at St.-Lô, the speed with which our armor moved across France made it necessary for us to throw the book out the window in many cases. Supply lines sometimes stretched as far as 150 miles to the fluid front. There was no time to store ammunition in ammunition supply points, so it was left in trucks and trailers which raced to keep up with the tanks. Soon, however, we were able to establish a base section in the communications zone. Here we set up more permanent supply depots which furnished the necessary matériel to forward supply units in the advance section, communications zone (ADSEC).

Prior to D-day, Ordnance was responsible for some 2,000,000 tons of equipment in England, including more than 300,000 vehicles, 1,500,000 small-arms weapons, and nearly 20,000 artillery pieces. From that time to V-E Day, Ordnance supplied 2,500,000 more tons to our own and allied troops.

THE work of Ordnancemen during this period comes in for the highest praise, for not only did they keep pace with the using arms, but they were obliged to engage in constant actions against bombers, strafing planes, and infiltrating ground troops.

Even after the front became more static as our armies approached the borders of Germany in the fall, the problem of hauling supplies scarcely decreased, for rail transportation in France was almost negligible. The answer was the famed "Red Ball Highway," over which an endless stream of trucks moved day and night, speeding to sustain our attacks. Soon we were able to shorten the supply line by moving our base depots forward from the coast. Paris became Ordnance service headquarters, and it was here that our activities were guided by Maj. Gen. Henry B. Sayler, of Huntington, Ind., Chief Ordnance Officer of the European Theater of Operations.

Just outside Paris we established De-

pot O-644 where thousands of combat and utility vehicles, weapons, and spare parts were broken down from bulk shipments for immediate reissue to supply points in ADSEC. With 2,000 officers and enlisted men, under the command of Col. Edward J. Towers of East Orange, N. J., this depot was the largest of any kind on the European Continent.

DURING the Battle of the Bulge, the ammunition problem once more reared its head, and one of the great achievements in this phase of the war was the unsung work done by Ordnance ammunition companies in supplying the troops with what they needed to throw the enemy back—and they needed plenty as shown by the fact that ammunition consumption during this period was 2½ times that of the terrific assault in the St.-Lô break-through campaign.

Despite subzero temperatures which stopped many vehicles and the fact that they were constantly fighting it out with fanatical Nazi units, Ordnancemen came through in the crucial period. While it would be impossible to mention every organization, one in particular is deserving of attention. This is the 71st Ordnance Group, under Col. Herbert E. DeLee of Dallas, Tex., which in one day supplied First Army troops with 7,500 tons of ammunition. This is believed to be a record figure.

However, after the Nazi counterthrust was beaten back and when our armies smashed ahead once more in their spring offensive, the familiar problem of mobility returned to the supply picture. The practice of leapfrogging ammunition depots and ammunition supply points was resumed, and once again fleets of trucks lined the German *Autobahns* to support the swift advance of our armor. For example, Ordnancemen of the Third Army in one week drove their ammunition trucks a distance which would encircle the globe over twenty times. This figure applies to Ordnance haulage alone and does not include distance traveled by vehicles of corps and division units.

Ordnancemen saw their share of action and, as at Normandy and the Bulge, proved that they were fighters as well as technicians. The job of bringing replacement tanks to the armored divisions became doubly difficult. Ordnancemen, after traveling for several days from rear areas, would find upon arrival at a predetermined rendezvous that our armor had picked up and moved ahead, thus making it necessary to spend hours and sometimes days in search of the division's new location, all the while dodging sniper's bullets and artillery shells.

During the final stage of the war, Ordnance supply worked harder than it ever had, and the great speed of our advance on all fronts is due in large part to the fact that our fighting troops never had to wait for their equipment. Supply was speeded up immeasurably by the use of depots like O-644 and the fact that we were able to handle a great deal of assembly on the European Continent itself. For example, between D-day and May 1945, vehicle assembly here reached a figure of 137,148.

To give an idea of the needs of an army for one month, and how Ordnance met them, let us look at the requirements of the First Army during January 1945. It received 1,123 combat vehicles, 3,300 general-purpose vehicles, 388 special-purpose vehicles, 5,017 small-arms weapons, and 95 artillery pieces. This was the supply picture of Ordnance in the European Theater of Operations.

Yet no gun or vehicle is any better than the shape in which it is kept, and that was the job of Ordnance field maintenance. From the very first day of the invasion, when seventeen gliders brought Ordnancemen to France to repair the equipment of air-borne troops, maintenance has been following the footsteps of front-line units, and in some cases has been ahead of the front.

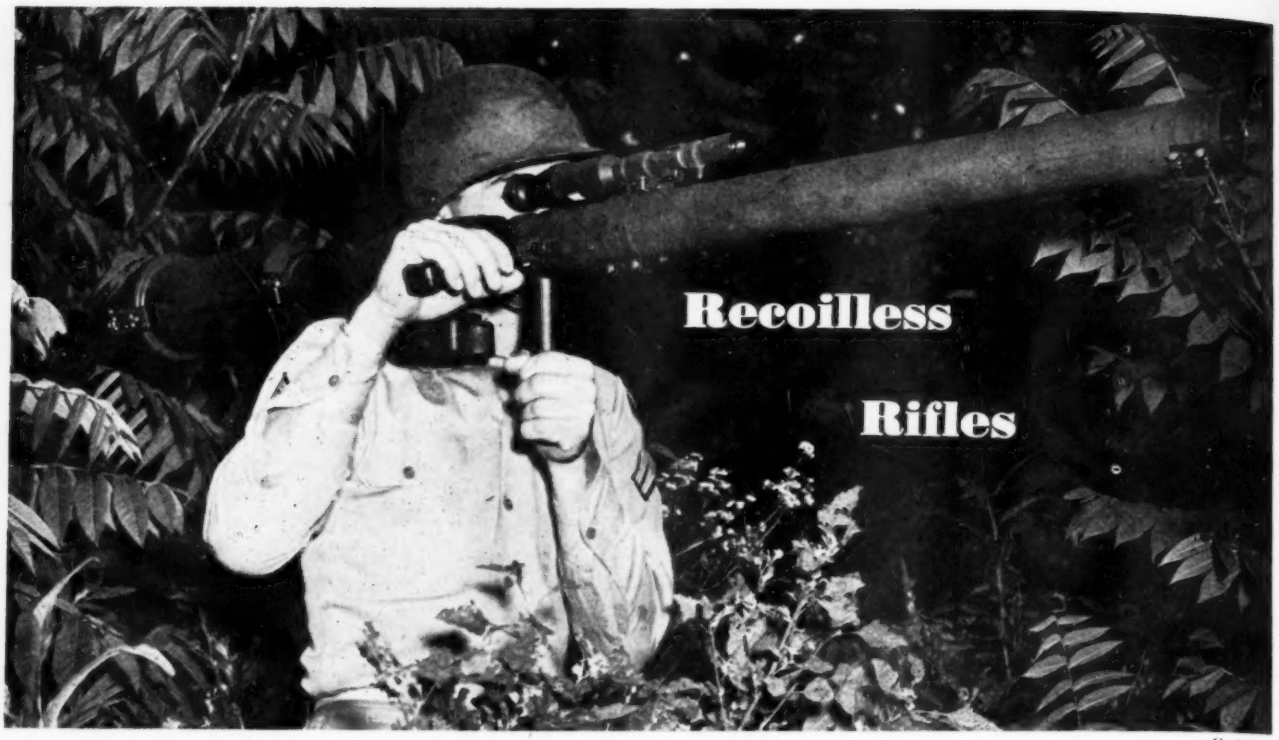
With the exception of base companies and battalions, all maintenance organizations are mobile so that they can pull up stakes at a moment's notice and pace the units which they are charged with servicing. There are automotive battalions, tank-repair companies, armament companies, small-arms companies, tire-repair companies, salvage crews, and many others. During the entire campaign, communication lines were constantly patrolled by automotive and tire units, ready to pull damaged vehicles off the roads and make the necessary repairs. Contact teams moved up to the front lines and did mechanical surgery jobs on our artillery while the enemy blasted away at them. No matter how difficult were the assignments for our welders, armament experts, and tank doctors, they never let the troops down.

Improvisation was the keynote of maintenance during the campaign, for the problems which faced Ordnance were not of such a nature that they could be solved by reading technical manuals. For example, when the Normandy hedgerows began to bog down our vehicles, maintenance men, using tetrahedrons left on the beaches by the Germans, built large blades and attached them to a number of M4 tanks, making "tankdozers" which were able to chop their way through the natural obstacles. In Germany, the Third Army was faced with a critical spark-plug shortage that was solved by Ordnancemen who made a number of adjustments on 40,000 captured plugs which were then used successfully by the Third's tanks.

DAMAGED equipment called for constant repair work, particularly during critical periods. In December, for example, battle losses in four United States armies were double those of the previous month, yet maintenance organizations of the Third Army alone put back into action more damaged guns and vehicles than were lost by the four armies during the same period. Between D-day and V-E Day, third-, fourth-, and fifth-echelon shops in the communications zone repaired 335,995 vehicles of all types, 407,182 small-arms weapons, and 11,182 artillery pieces, a total of 754,259 jobs.

For every small-arms weapon lost, two have been repaired, while the artillery ratio is twelve repaired for each piece lost. A great deal of the economy in repair work is due to the Ordnance salvage program. When a weapon or vehicle is damaged beyond repair, salvage crews strip it of every part which may be used again on some other item. In fact, more than fifty per cent of the parts in most classes of equipment are used in two or more major items.

It would require volumes to describe adequately the unsung work of 150,000 officers and enlisted men who delivered the goods to our fighting men and kept those goods in fighting shape in the European Theater of Operations. However, our job is not yet finished. Ordnance has done its part in the defeat of Germany, but maintenance and supply won't end until the last Ordnance company services the last gun which fires the last round into Tokyo.



Ordnance

They Give Field-Artillery Firepower to the Infantry

Col. René R. Studler

THE recent standardization of the 57-mm. rifle M18 and the 75-mm. rifle M20 marks the culmination of a phase of Ordnance development which is almost a textbook example of directed research. This brief sketch of a project which grew out of an unwillingness to accept apparently unavoidable compromises in weapon performance and which yielded a new implement of warfare is presented in the belief that it not only chronicles the growth of an important item but that it is typical of a class of work, great in scope, yet little known even in Ordnance circles.

In the spring of 1943 the "bazooka" was an established weapon. Experiment and combat had shown its power and versatility, and only minor design improvements seemed practicable within the limitations imposed on it as a shoulder-fired, man-carried weapon. Inherent in its basic concept, however, were two serious and related disadvantages: its low velocity made for relative inaccuracy and short range, and its rocket projectile carried a high percentage of dead weight in motor and fins—even the propellent charge had to be moved while burning with the rocket.

Colonel Studler is chief of the Small Arms Development Division, Ordnance Research and Development Service.

Repeated discussions brought out the advantage of separating this dead weight from the projectile and retaining the motor in the launching weapon. This led to a study of the Davis gun of World War I, the work of Dr. R. H. Goddard, and the patents of Charles J. Cooke and others. It was decided that specific inquiry should be directed toward the practicability of firing a conventional-type projectile from a rifle which would counteract recoil by the discharge of a portion of the gases from the propellant.

On June 7, 1943, J. C. Gray and Lieut. Col. (then Maj.) John R. Bird of the Small Arms Development Division, Office, Chief of Ordnance, requested that a project to develop a nonrecoil rifle be undertaken at Frankford Arsenal. In late June and July 1943, basic papers covering the fundamental theory of this new type of weapon were prepared at Frankford Arsenal by Dr. W. J. Kroeger under the direction of Lieut. Col. C. H. Greenall and were reviewed by Dr. M. C. Stuart of Lehigh University. Immediate experiments were begun with a simple, smoothbore gun embracing a complete study of interior and exterior ballistics.

In September 1943, design of an actual gun and round was started by C. Walt Musser, assigned by Colonel Greenall as mechanical engineer on this project. It was decided to use a 57-mm. tube for this weapon, and a projectile weight of approximately 2¾ pounds was agreed upon—dictated largely by interior-ballistic considerations. The preliminary design was completed with test work proceeding concurrently, and the second weapon furnished sufficient data to make a firm design practicable by October.

This design was assigned the nomenclature "rifle, recoilless, shoulder-type, T15," and a pilot model was built and given preliminary firing tests during October. This rifle employed a perforated cartridge case supported in a chamber which provided a substantial open space about the case and Venturi-tube openings between the breechblock supporting lugs. This arrangement permitted escape to the rear, on firing, of a controlled amount of the gases.

On November 8, 9, and 10, 1943, the T15 rifle, weighing about 40 pounds and firing a 2¾-pound projectile at 1,000 feet a second, was demonstrated at Aberdeen Proving Ground, and made a target pattern 23 by 21 inches at 300 yards when fired from an M2 machine-gun tripod. No recoil was evidenced in these firings.

Following this test at Aberdeen, immediate construction of another T15 rifle was authorized and experiments initiated to increase the muzzle velocity to 1,200 feet a second on this rifle. Specific projects were set up on powder assessment and case design, and the appropriate facilities within the Research and Development Service were advised of the problems of shell and fuze design and of fire-control equipment design.

AT this time it was decided to relieve the pressure of work rapidly increasing at Frankford Arsenal by engaging the services of a commercial engineering and manufacturing group to undertake the production of a small number of 57-mm. recoilless rifles, at the same time revising the basic design to incorporate certain new features indicated as desirable. The Frigidaire Division of General Motors Corporation, Dayton, Ohio, agreed to undertake this work, and the first research and development contract was issued to them on January 29, 1944.

Meanwhile, the muzzle velocity was increased to 1,200 feet a second. The rifle was shoulder-fired by Maj. (then Capt.) L. B. Hedge of the Small-Arms Development Division, and a demonstration of the weapon before the Infantry Board was given in February 1944. Following recommendations of the Infantry Board based on the February demonstration, the Army Ground Forces requested production of weapons and ammunition for test and development of a 75-mm. weapon. High-explosive, hollow-head antitank, and white-phosphorus rounds were requested for both weapons.

Development of accessories was undertaken by various commercial agencies under detailed Ordnance supervision. These included iron sights and telescope mounts by Frigidaire; shoulder-rest and bipod-monopod combinations by Fleetwings Division of Kaiser Cargo, Inc., Bristol, Pa.; covers and pads by Crawford Manufacturing Company, Richmond, Va.; and face shields by the Johns-Manville Sales Corporation, New York, N. Y.

Design of the 75-mm. rifle T21 was started at Frankford Arsenal following preliminary firings of experimental models. This weapon, firing standard 75-mm. shells at 1,000 feet a second (the maximum velocity allowed for the high-explosive antitank round), was completed in August 1944, and preliminary firings proceeded successfully during September 1944. It weighed 105 pounds and was mounted on the M1917A1 machine-gun tripod.

IN these pages is told the story of one of the Ordnance Department's more spectacular pieces of research and development—the recoilless rifle. It is too early to make an accurate and complete appraisal of this new type of weapon, but it may be said with conservative assurance that it promises to make fundamental changes in the character of ground warfare, both offensive and defensive.

Outstanding as a development, placing weapons of unprecedented striking power in the hands of the individual soldier, the recoilless-rifle project is also a brilliant example of the effectiveness of the Industry-Ordnance team and of the internal coöperation among various Ordnance groups in carrying to a successful conclusion an accelerated program of theoretical research and mechanical applications. Starting with a request for basic work in pure physics, these weapons with ammunition were in combat use within twenty-one months.—MAJ. GEN. G. M. BARNES, *chief of Ordnance Research and Development Service.*

Meanwhile, 57-mm. rifles in several variations had been designed and pilot models built. The first service-test lot, designated T15E7, was built and distributed to test facilities and service boards during August and September 1944. These rifles were similar, except for incidental changes in design details, to the original T15 rifles. A fundamental redesign progressed through type T15E9 during this production, and this design was cleared for manufacture of the second service-test lot on August 20, 1944.

On September 26, 1944, a demonstration of the 57-mm. and 75-mm. rifles took place at Aberdeen Proving Ground before representatives of the War and Navy Departments. Immediately following this demonstration, limited procurement of the 75-mm. rifle with accessories and ammunition was initiated.

A research and development contract for production of a pilot lot of T21 rifles was negotiated with the Miller Printing Machinery Company, Pittsburgh, Pa., which had been engaged to produce the T21 on limited procurement. Further development on this rifle to include certain design revisions was assigned the National Forge and Ordnance Company, Warren, Pa., which was already engaged in another phase of the recoilless-rifle program.

Early in 1945, demonstration teams made up of Infantry and Ordnance personnel were dispatched with both 57-mm. and 75-mm. rifles to each of the four then active theaters of operations. In March 1945 two Ordnance officers and one Infantry officer accompanied a shipment of fifty of each type of rifle with ammunition to the European Theater for special operational use. The officers instructed troops preparatory to employment of weapons and went with using units into the combat zone, assisting in maintenance and observation.

Changes in design dictated by observation of weapons in combat were initiated during April and May of 1945. Designs of both weapons were now felt to be adequate to service use, and standardization of both was completed at the request of the Army Ground Forces during June. Col. J. B. Rose has been of great help in furthering the mass of work done at Frankford Arsenal, and almost every division of the Research and Development Service has been called upon for assistance in some phase of the project. Ammunition development has been directed by Col. I. A. Luke, with conspicuous work by Col. W. W. Holler, Lieut. Col. J. E. Cox, and H. G. Rowner of this staff, and Col. M. G. Kresge and Maj. T. C. Ohart of Picatinny Arsenal.

THE using services have coöperated fully in making service tests and advising on user problems. Notable in this connection has been the assistance of Maj. Gen. Albert W. Waldron of the Army Ground Forces and Col. Ingomar M. Oseth of the Infantry Board. Only the restrictions of space prevent specific acknowledgment of the services of the many others whose active assistance is appreciated.

AUTHOR'S NOTE.—The acknowledgments indicated herein are of necessity incomplete. The entire project has received the continued interest and support of Lieut. Gen. L. H. Campbell, Jr., and Maj. Gen. G. M. Barnes. Lieut. Col. John R. Bird has been in direct supervision of the development, and Maj. L. B. Hedge has been the project officer assigned to these weapons.

The New 57-mm. Recoilless Rifle

The 57-mm. recoilless rifle M18 weighs but 45 pounds as against 2,700 pounds for the 57-mm. antitank gun on wheeled carriage. It is 61 inches long and fires a 3-pound high-explosive shell a distance of 2 miles. One man can handle the weapon if necessary, but normally one man aims and fires while another loads. The rifle may be fired while standing or prone (Ordnance photos).

The Recoilless 75-mm. Gun M20

The 75-mm. M20 weapon weighs 110 pounds, compared with the 3,400 pounds of the standard 75-mm. gun and carriage, and fires a 14-pound shell 4 miles. It is 82 inches long and is mounted on the standard caliber .30 machine-gun tripod. Used for the first time on Okinawa as shown in the Signal Corps photo above, the gun proved most effective. A battery is shown in action below.

Recoil Elimination

An Ordnance Problem Study—With an Answer

Maj. L. B. Hedge

The elimination of recoil from firearms is a problem that long has beset ordnance engineers. How it was finally solved in the Army's new 57-mm. and 75-mm. recoilless guns is told here for the first time.

THE elimination of recoil accomplished in the new 57-mm. M18 and the 75-mm. M20 rifles provides the American soldier with a working solution to a problem as old as gunpowder itself. Recoil has been a basic problem in all firearms since their earliest use. Its elimination or reduction has been the subject of much serious work by gun specialists and of much wasted energy by uninformed amateurs. A brief word on the nature of recoil and some earlier recoilless weapons, makes a good introduction to a discussion of the basic design common to the M18 and M20 rifles.

In a conservative physical system each action is accompanied by an equal and opposite reaction. A firearm of mass M which discharges a projectile of mass m at a velocity v will itself be driven away from the projectile with a velocity V such that, to a first approximation at least, $mv + MV = O$. A portion of the propellent gas follows the projectile, adding to the effective value of M. The momentum thus delivered to the gun must be dissipated in heat, consumed in performance of useful work, opposed by an equivalent momentum or force oppositely directed, or some combination of these three. The third alternative—opposing the gun's momentum by an equal and opposite one—is the only scheme which will make the gun recoilless.

An obvious way to provide this opposite reaction is to mount a second gun coaxially with the first and fire both together in opposite directions. This arrangement, patently useless as a practical weapon, provided, nevertheless, a basis for a recoilless gun design—the Davis gun of World War I (U.S. Patents 1,108,714 through 1,108,717; 1,395,630; 1,446,000; and 2,156,605).

Comdr. Cleland Davis designed several recoilless guns, the most interesting of which provided two coaxial barrels directed oppositely from a central powder chamber. A conventional projectile was loaded into one barrel, and a mixture of grease and lead shot of the same weight as the projectile was loaded into the other barrel. This scheme provided a usable, if awkward, recoilless gun, and an extensive patent literature testifies to the interest focused on this weapon.

A simpler, if slightly less obvious, solution to the problem is furnished by an open tube into which is loaded a projectile and a propellent charge. On ignition of the charge the projectile moves forward, and a large volume of powder gas moves rearward. This gun, though inefficient, is surely close to recoilless, since only the friction of the projectile and gases can act to apply any force to the tube parallel to its axis.

A CONSTRICTION of the tube at a point behind the charge in the gun described above furnished a simplified version of the Cooke recoilless gun (U.S. Patent 1,380,358). An accurate simplified analysis of this gun is not possible. Roughly, however, we may conclude that constriction of the rear passage increases the velocity of escaping gas, raises the internal pressure, and also increases the muzzle velocity of the projectile. Recoillessness becomes a function of the bore area to escape-port area ratio, projectile mass to charge mass ratio, loading density, powder granulation and composition, burning temperature, and other factors.

Two types of recoillessness must be distinguished—"mean" and "absolute" will serve to identify the two concepts. The forces of propulsion, exerted by the gas from the burning powder on the gun and projectile, are operative over a short interval of time—of the order of a hundredth of a second. A gun may be said to be recoilless in the mean if the total momentum applied to it over the firing period is zero. This will permit large forces to appear, unneutralized, during parts of the pressure interval and other oppositely directed forces during other portions of the combustion cycle. Absolute recoillessness, on the other hand, will require the force tending to make the gun recoil at any instant to be opposed by an equal and opposite force.

Visual observation of a recoilless gun will probably give no clue as to the type of recoillessness it exhibits since, with the weights and times involved, no motion will be apparent with either type of balance. Gun mountings, however, must take account of the difference since a gun, recoilless in mean only, may transmit tremendous stresses to a mount not sufficiently flexible to permit their absorption by the inertia of the weapon itself. An absolutely recoilless weapon will place no firing stresses on its mount.

Based on a precise analysis of the interior-ballistic factors mentioned above, early experiments at Frankford Arsenal made use of a smoothbore gun with adjustable exit ports at the breech and a chamber volume adjustable by positioning of the projectile in the tube. Data in confirmation of the early analysis were obtained, and extended relations among charge weight, projectile weight, chamber volume, projectile travel, and muzzle-velocity and time-pressure travel curves were obtained. These data were made the basis of a preliminary mechanical analysis which indicated that a weapon firing a projectile weighing nearly 3 pounds at 1,000 feet a second could be built weighing less than 50 pounds, yet with a liberal safety factor.

WITH a 1-man weapon thus indicated as possible, weight and size became critical factors. Increase in maximum pressure would require increased strength and greater weight. Increased projectile travel would per-

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mit a decrease in pressure but an increase in the length of the weapon. An increase of the ratio of average pressure to maximum pressure (possible in this as in conventional guns by an adjustment of loading density, powder web, and weight of propellent charge) would reduce the maximum pressure and the travel, or both, at the expense of increased complete-round weight. For examples, see "Elements of Ordnance," by T. J. Hayes, New York, 1938.

No ideal solution exists. The opposed weight and ballistic-performance criteria were compromised to yield the basic proportions incorporated in the original Frankford Arsenal T15 rifle and retained through subsequent experimental models to the final 57-mm. M18 rifle now standard.

THE basic weapon comprises an enlarged chamber, partially closed at the rear by a breechblock containing Venturi tubes and the firing pin, and opening at its forward end into the rifled tube. The round, consisting of a loaded primed case, perforated to permit gas escape and with its projectile crimped into its mouth, is supported by the breech and the tube and is head-spaced from a ring attached to the case near its forward end. The shell is fitted with a pre-engraved rotating band which is engaged with the rifling of the tube on loading. Inclination of the Venturi openings with respect to the rifle axis counteracts the torque transferred to the weapon as a reaction to the angular acceleration of the projectile.

Pre-engraving of the projectile, employed initially to approximate the conditions of the smoothbore test rifle in the rifled test weapon, has been retained for its advantages in reducing performance variations from round to round, reducing weight by elimination of engraving stresses in the tube, and reducing the probable departure from absolute recoillessness in the actual weapon. These features will be clarified by a consideration of the engraving process in a recoilless rifle.

A conventional shell with its rotating band seated at the origin of rifling will not move forward under the action of the burning propellant until the pressure on the base of the shell has reached a value high enough to force the band through the lands. This "engraving pressure" is known to vary widely from round to round under the closest possible controls on rotating-band production.

In order to provide absolute recoillessness with such a shell, some retaining element must be provided to permit no rearward gas discharge until the "engraving pressure" has been reached. Opening of this retaining element either before or after commencement of engraving will momentarily destroy the balance of force, and an initial momentum will be delivered to the rifle which must be counteracted later in the firing cycle when both projectile and gas discharge have become stabilized.

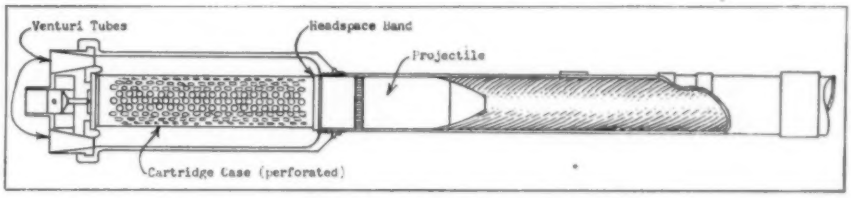
Experiments to date have indicated only one feasible method of approximating this release of the gas discharge at the engraving pressure. This method provides a closure to the gas ports of the propellent case itself with some material which gives way at the proper pressure. Variations of sensitivity of this "blowout" element at the pressures required, with the above-indicated variations of engraving pressure, make substantial departure from absolute recoillessness an inherent characteristic of this type of design.

From a weight-conservation point of view, normal engraving of the projectile rotating band presents serious disadvantages. Engraving imposes tremendous stresses on the tube at the origin of rifling and requires additional strength in the tube, which can be supplied only by increasing its thickness and consequently its weight.

We have seen that pre-engraving the projectile eliminates the necessity for establishing engraving pressure by a "blowout" element. There still remains a problem of the same character arising from mechanical rigidity requirements for a fixed round of ammunition. The projectile of a fixed round must be secured in the case with sufficient firmness to permit reasonable handling of the round without damage. This means that some substantial force must be required to unseat the projectile from its case, and in the rifle this force, like the engraving force, must be furnished by a pressure built up in the chamber before the projectile commences to move.

The magnitude of this so-called "bullet pull" is normally subject to large variations from round to round. Extensive experiments, conducted under the direction of the Ordnance Artillery Development Division, led to establishment of controls which hold this factor within close limits. This "bullet-pull" pressure threshold, when accurately controlled at a low value, becomes an advantage to the operation of the rifle. A low-pressure "blowout" element is supplied in the form of an impregnated paper liner for the perforated cartridge case, and the pressure built up before either the projectile or the gas discharge begins assists substantially in the uniform ignition of the propellent charge.

EARLY models of the 57-mm. rifle had established the basic design as sound. Continued firings of these weapons showed that Venturi tube design had great influence on the rate of erosion and consequent life of the breechblock with its gas ports. Existing literature provided little applicable information on this phase of design in the temperature and pressure ranges involved.



Cross-section view of the 57-mm. M18 rifle.

A program of research was consequently initiated at Aberdeen Proving Ground. Capt. J. H. Wiegand was assigned to this work, and results obtained furnished precise information on contour and materials for Venturi tube ports which more than doubled their life. Replaceable elements permit compensation for normal wear.

The fundamental problems of the 75-mm. rifle are similar to those met in the 57-mm. weapon, and the standardized models are essentially similar. However, increased projectile and charge weight and changes in powder granulation made one notable difference in the final solution. The larger proportions of the chamber and round make possible the head spacing of the round from the case rim at the back—eliminating the sleeve—and also permit the use of a tapered case.

The Ribbon-Frame Camera

A New Device for Photographing Rockets in Flight

C. N. Hickman

In the development of rockets for the Ordnance Department, a motion-picture camera was urgently needed to take photographs of rockets while they were being launched and accelerated, and the ribbon-frame camera was developed for this purpose. It has a speed of 120 frames a second, with exposure times ranging from 0.0001- to 0.0006-second. From its pictures ignition time, burning time, velocity, acceleration, and yaw of the projectiles may be accurately obtained.

IN studying the launching and acceleration of rockets, it is necessary to obtain a series of photographs at short intervals of time. Since the distance of travel of the rocket during its period of acceleration is large, the field of view of the camera must be great. On the other hand, since the rocket travels in a relatively straight line, the field of view at right angles to the motion of the rocket may be quite small.

To obtain the desired pictures of rockets being developed for the Ordnance Department, it was necessary to design a motion-picture camera widely different from any then on the market. Small size and weight have been secured by the use of a drum-type shutter system. The first camera built was designed at the Bell Telephone Laboratories.

Fig. 1. Front view of the camera.

The camera (Fig. 1) uses a standard No. 122 film, which is 3¼ inches wide and 35 inches long. The film is carried past an 0.25-inch slit, and each frame is thus 0.25-inch high and 3¼ inches wide. Over 200 frames may be taken on a single film. The exposure time is adjustable from 0.0001- to 0.0006-second. A dial on the outside of the camera indicates the amount of unused film, and, where the number of frames taken for each set is small, several sets may be taken on the same film.

One of the novel features is the shutter arrangement. It consists of 2 concentric drums 2¾ inches in diameter and 4½ inches long which are rotated in the same direction but at slightly different speeds by a single constant-speed motor. In each drum there are wide slots running nearly from end to end—four in the inner and five in the outer. The inner drum, coupled directly to the motor, rotates at thirty revolutions a second, while the outer drum is driven at twenty-four revolutions a second through a gear train from the inner drum.

These two drums are shown in cross section in Figure 4 as they would be at some particular instant. For purposes of identification, the edges of all slots are lettered—*A* to *J* for the outer drum, and *K* to *R* for the inner. In the position shown, there is a 40-degree gap through both drums at the right, and a 4-degree gap at the left between edge *A* of the outer drum and edge *K* of the inner. Because of the difference in the number and spacing of the slots and of the difference in speed of the drums, these same two gaps, wide at the right and narrow at the left, will appear after each quarter revolution of the inner drum.

FOUR times for each revolution of the inner drum, therefore, there is a wide opening at the right and a narrow opening at the left; for the rest of the time the slit is completely covered by the solid sectors of the inner or outer drums. By mounting a light source and a suitable optical system at the right and arranging to carry the film past the slit at the proper speed, exposures may be made at the rate of 120 a second—4 for each revolution of the inner drum.

Just outside the outer drum is a light shield with an 0.25-inch slit opposite the *AK* gap shown in Figure 4. The film rides over the surface of the light shield from a supply roll above the shutter to a take-up roll below them. It is driven through gears from the shutter-drive motor and runs about 0.24-inch a second—varying slightly from this value as the supply reel empties and the take-up roll fills up.

Because of its continuous motion, the film will move from two to ten-thousandths of an inch during the short exposure time. To prevent the blurring of the image that such motion might cause, four glass plates, ground optically flat, are attached to the inner drum just inside the four slots, as shown in Figure 2. As the shutter rotates, these prisms—because of the change in the angle of refraction as they rotate—move the image at the same rate as the film. Thus, during the transit of the film they pass the gap, and the image remains fixed with respect to the film.

As already mentioned, the outer drum is driven from the inner drum through

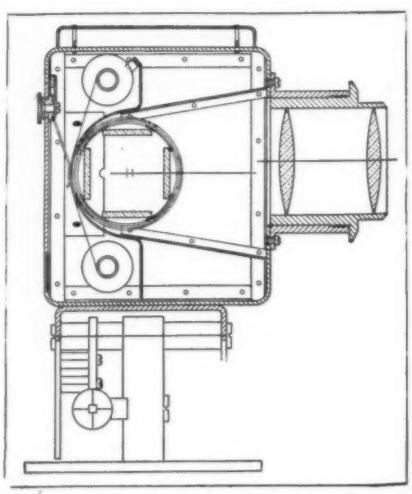


Fig. 2. The camera in cross section.

Dr. Hickman is in charge of rocket development work, Section H, of the National Defense Research Committee. He is also a physicist with the Bell Telephone Laboratories.

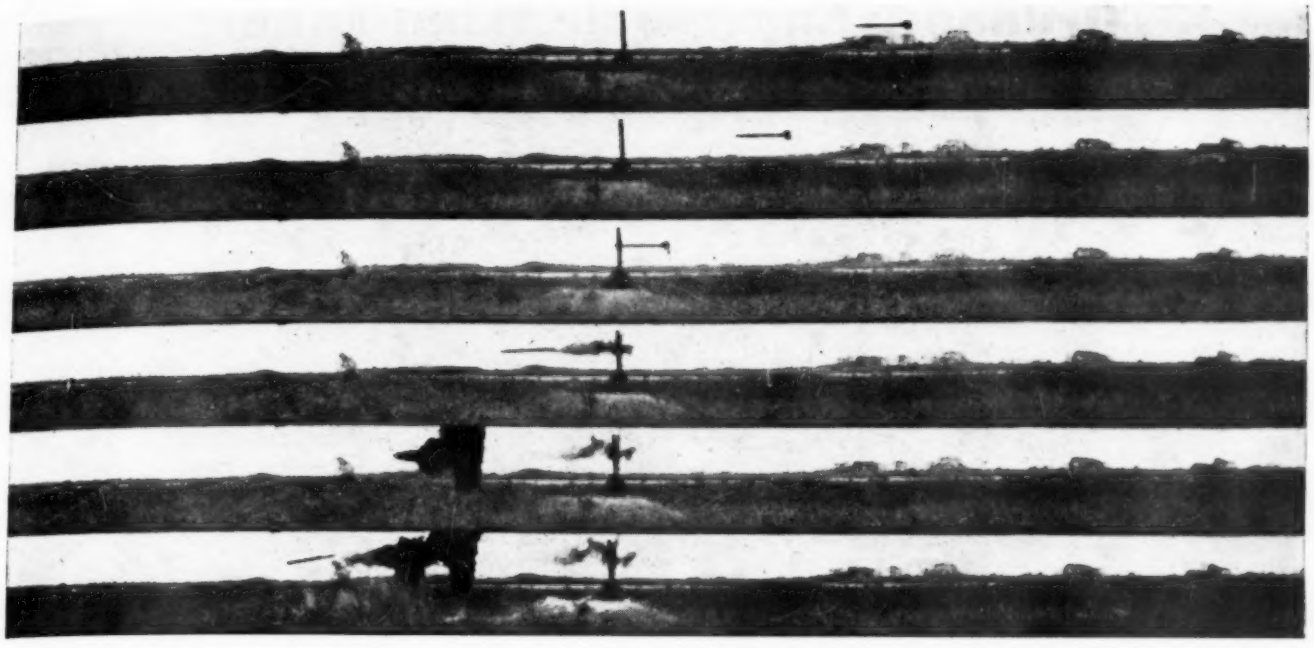


Fig. 3. Part of a film strip taken by the camera showing a 4½-inch fin-stabilized rocket being fired at armor plate. Frame 3 shows the rocket piercing the plate, Frame 4 the complete penetration, and Frames 5 and 6 the bursting of the delayed-action charge.

a gear train. One of the elements in this chain is a planetary gear rotating around a stationary gear. If the stationary gear is rotated, the relative positions of the inner and outer drums will be displaced proportionately.

An arm fastened to the stationary gear is mounted on the outside of the camera. This arm is brought to a point at its upper end, and its position is indicated by a scale marked in exposure time. As the arm is moved to various exposure times, the stationary gear is rotated so as to make the gap *AK* the proper width to give the desired exposure.

All light is excluded by the shield from the rear compartment of the camera except that passing through the slit. The back of the camera is hinged along the bottom edge and may be opened for inserting or removing the film, as shown in Figure 5. On the top of the camera is a fan-shaped view finder. The wide end on the lens side of the camera has a narrow slit that marks out the field of view, while at the narrow end in the rear is a small peephole.

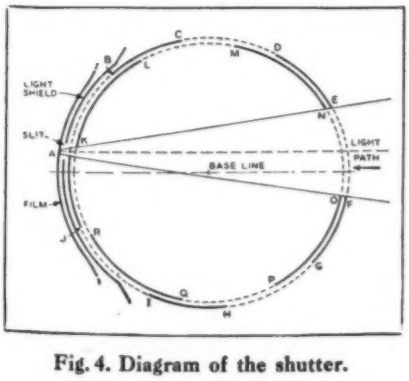


Fig. 4. Diagram of the shutter.

IN preparing to take a set of photographs, the camera is set up at such a distance from the path of the projectile that the desired section of the path will be included. When the path is not horizontal, the camera is tilted to the proper angle by a thumbscrew just behind the graduated scale, part of which is shown in Figure 5. When the angle of fire is known, this angle may be set on the dial.

As the rocket or shell is fired, the clutch button just below the motor is pressed. This connects the film roll to the drive, and by starting the film starts a set of exposures. Exposures will continue to be made as long as the clutch is held in. Exposures are continued at the rate of 120 a second as long as desired or as long as the film lasts. If the total time needed is less than the time required to run all the film through the camera, the operating clutch is released and the film stops.

As many as six series of pictures may often be taken on the same film, which is about thirty-five inches in length. The resulting record is a series of narrow photographs adjacent to each other as in Figure 3. The rocket will thus be shown at its respective position each one hundred and twentieth of a second. The convenience of having a record in which all the frames are on the same page is apparent.

By measuring the distance that the rocket has traveled between adjacent frames, its velocity at that moment may be determined. Plotting these velocities as a function of time and differentiating will give the acceleration of the rocket. The burning time of the rocket, both inside and outside the launcher, may readily be determined by the flash.

In like manner, the ignition delay can be determined because the nature of the flash of the igniter is readily distinguishable from that of the propellant.

Many of these cameras have been constructed and are being used by the various rocket-developing and proofing agencies throughout the country. While the camera was designed primarily for studying rockets in flight, it is also being used for studying the flight of projectiles. It is obvious that it is useful in studying the motion of any object which travels in approximately a straight line.

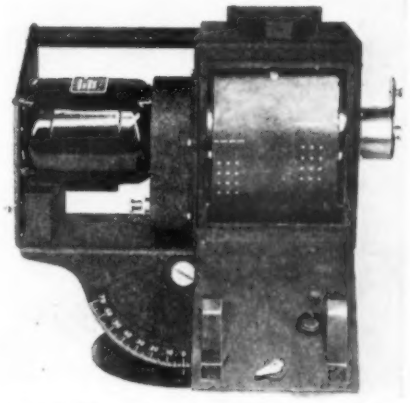


Fig. 5. Rear view showing film position.

Ordnance Supersonic Wind Tunnel

Above is the new $2,000,000 supersonic wind-tunnel laboratory at Aberdeen Proving Ground, Md., for testing ballistics of bombs and projectiles. Air speeds of more than 1,300 miles an hour can be obtained. Below, Dr. Edwin P. Hubble, noted astronomer in charge of exterior-ballistics research, and Lieut. M. W. Conti examine part of the bomb-testing apparatus (Ordnance photos).

Radar—Past, Present, Future

The Use of Microwaves in Radio Detecting and Ranging

Gordon Ferrie Hull, Jr.

Microwaves have long been known to science, but their modern application through the use of special equipment has effected almost miraculous results in defeating our enemies in this war. They hold an even greater promise of future accomplishments.

"ON the night of November 14, 1942, off Guadalcanal, there lay a Japanese battleship. It was a stormy night. Eight miles away was a ship of our own fleet. With the use of radar our ship, with its second salvo, sank the Jap battleship in the blackness of the night, eight miles away."

Spectacular achievements such as this, quoted from a recent statement by Secretary of State James F. Byrnes, have served to make radar a key weapon in the war today. At the present time, security regulations forbid the disclosure of specific radar equipment. Nevertheless, the basic theory and experiments behind the development of radar are well known and can be discussed.

Radar, which stands for radio detecting and ranging, makes use of very short radio waves. These are generally called microwaves. In order to define these waves, an analogy with water waves serves excellently. Ordinary ocean waves, for instance, are measured by the distance between two adjacent whitecaps. This distance is called one wave length and ocean waves (although they can vary considerably) are roughly 300 meters long.

Transfer this thought to radio waves.

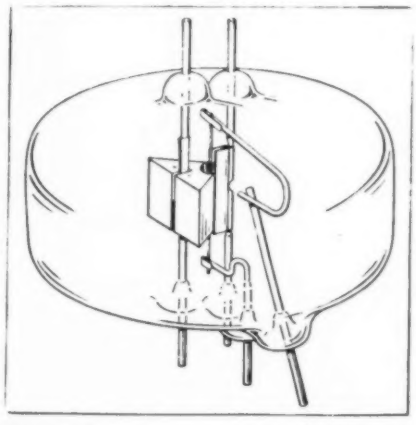


Fig. 1. The Western Electric 368A 3-element tube for producing microwaves.

These are electric waves which have "whitecaps" or crests similar to water waves. In ordinary radio broadcast waves, the wave length is roughly 300 meters, corresponding in length to ocean waves.

Microwaves, under which radar can be classified, include those electric waves having wave lengths from one meter to a few centimeters. To complete the water-wave analogy, these might correspond to ripples on a small pond, produced by the dropping of a pebble.

Microwaves are the shortest radio waves which can be produced today. Because they are so short the apparatus needed to produce and detect them is very different from ordinary radio apparatus, for the size of the apparatus is roughly the same size as the waves themselves. Special equipment for producing and detecting very short waves will be described later in this article.

The public is startled by the newness and the tremendous possibilities of these very short radio waves, but few outside the scientific field realize that waves of this length were the first radio waves ever discovered. In 1888 the German physicist Heinrich Hertz produced electric waves from sparks which had wave lengths of about thirty centimeters. Had he invented radar then, Germany might have won several wars in the meantime!

Hertz was able to detect these waves, measure their length, and transmit them across the large attic of the Physical Institute at the University of Bonn. These experiments by Hertz culminated the great theoretical work of the British physicist James Clerk Maxwell, who predicted the existence of electric waves in 1866, twenty-two years before Hertz.

From that time on, little was done with the practical development of radio until Marconi went to very long waves which enabled him to produce transatlantic radio telegraphy. It might be said that Marconi took a step backward, as far as wave lengths were concerned, in order to make the great step forward in radio telegraphy. Long radio waves were necessary at that time in order to produce waves of sufficient energy to travel great distances, a thing which was not possible with Hertz's original apparatus.

Since then, physicists have been struggling for many years to get back to the short waves of Hertz. However, in returning to Hertz we have returned with a tremendous power which he never dreamed of. That power is the modern radio electronic tube. It was the discovery of the electron by Sir J. J. Thomson in 1897 which made the radio tube possible.

Subsequently, the development of the electron tube was carried out by many scientists, based on Thomson's discovery and later on the work of Sir Owen Richardson. These included Fleming in England, DeForest in this country and, last but not least, the great teams in the industrial physics laboratories of the United States. The development of the electron tube and of electronics has received a tremendous stimulus from the present war. The most recent achievements cannot as yet be disclosed.

IT IS the electron tube rather than Hertz's sparks which today is used to produce microwaves. A typical tube for producing microwaves is the Western Electric 368A shown in Figure 1. In many respects this triode is similar to the ordinary radio tube. However, the reader will note several distinct differences in design. For example, the prongs of the tube come directly through the glass envelope instead of being mounted on a base as in the more conventional radio tube. This microwave tube also has closer spacing between the tube elements to minimize the electron transit time between cathode and plate. The tube oscillates up to frequencies of about 1,500 megacycles, or a wave length of 20 centimeters.

To make use of the 368A tube for the production of microwaves, an especially

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designed transmitter is required differing very greatly in its physical structure from the ordinary type of radio broadcast transmitter. Such a transmitter is shown in Figure 2. Figure 3 shows the arrangement of the 368A tube in this transmitter.

To all appearances the transmitter and

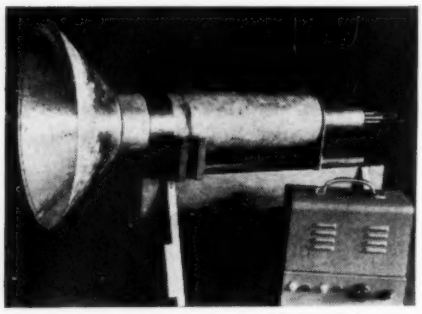


Fig. 2. The 20-cm. transmitter.

receiver appear to be made largely of stovepipe, to the end of which horns are attached. However, inside the transmitter pipe is the Western Electric 368A tube producing the 20-centimeter microwaves. The waves are then transmitted down the pipe and radiated into space by the horn antenna. One can think of the horn antenna as acting like a megaphone for these waves in the same way that an ordinary megaphone acts to direct a person's voice.

The value of pipes for transmitting radio waves was known at least theoretically as far back as 1896 when Lord Rayleigh first worked out the theory of this type of electric wave transmission. Practical and experimental realization of this theory was not achieved, however, until very recent years when Dr. G. C. Southworth of the Bell Telephone Laboratories carried out his significant experiments on the transmission of electric waves through pipes. The technique which he developed is one of several which are basic in much microwave work. For it is possible to run these waves through stove or drainpipe around bends and elbows with some of the plumbing fixtures which can be obtained in any hardware store. Plumbing is becoming, these days, an important branch of physics!

The "20-centimeter" receiver which is also pictured in Figure 4 is in some respects the exact converse of the transmitter in that it consists of a horn for an antenna and a piece of stovepipe—the pipe in this case containing a piston and a crystal detector. In many ways this is a return to the old days of radio and "crystal sets." For in the region of microwaves the crystal detector is usually found to be more adequate than radio tubes. The receiver is tuned by moving the piston back and forth. Figure 5 shows the arrangement of the piston and the crystal detector in the receiver.

With this apparatus one can show many of the properties of microwaves and the principles upon which radar operates. For radar is merely the application of microwave principles and techniques to the problem of locating objects.

One of the first properties of microwaves which can be demonstrated with the apparatus is what might be termed "the searchlight principle"; namely, that these radio waves travel in a straight line like a beam from a searchlight and will not bend around corners as will ordinary longer "broadcast" waves. For example, if the "20-centimeter" transmitter is put on one side of a fairly large sheet of copper and the receiver on the other, none of the waves get around the edges of the copper sheet. However, if the receiver is placed alongside the transmitter, the waves can be reflected from the copper sheet back into the receiver in the same way that a beam of light is reflected from a mirror.

ONE other fact of importance is that the horn antenna can be made highly directive for these very short waves. Consequently it is possible to obtain a radio beam much like a searchlight beam, which can be swung about at the will of the operator.

It is true that a beam can be produced for longer radio waves, even in the broadcast range, but this would require apparatus enormous in its physical size and which could not be swung about easily.

Another important property is the fact that radio waves in general will penetrate fog, clouds, and mist, while a searchlight beam will not. Furthermore, radio waves travel with the speed of light—186,000 miles a second—which means that the time interval between a transmitted and received signal is extremely small.

It is these properties of straight-line propagation, directivity, penetration of fog, and reflectivity, as well as speed, which make microwaves particularly useful for radio detecting and ranging.

A simple radio locator, known as the absolute altimeter, was developed before the war by the Bell Telephone Laboratories for measuring the height of an airplane above the ground. This consists of a microwave radio transmitter and receiver located in the airplane. A beam is sent out from the transmitting antenna which strikes the ground and is reflected back to the receiving antenna in the airplane. The time which it takes the radio beam to go to the ground and return is measured by means of appropriate apparatus, and thus the height of the airplane above the ground can be calculated.

EVIDENTLY if this altimeter were placed on the ground and an airplane flew overhead and intercepted the beam from the transmitter, the plane would reflect some of the beam back to the altimeter receiver on the ground. In this case the "altimeter" has found the height or the range of the airplane, and one has, in essence, a radar.

Two of the major problems which had to be solved in perfecting the altimeter and radar have been, first, devices for measuring time and, secondly, methods for producing sufficient microwave power.

Suppose we consider an airplane flying 1,500 yards above the ground. A radio locator on the ground would have to measure the time that it takes the microwave signal to go out to the plane and back in order to determine the range. Since the speed of light is approximately 300,000,000 yards a second, the time required for the signal to go out to the plane and back is 10 microseconds (twice 1,500 divided by 300,000,000).

This example will serve to show that the time intervals which must be measured in order to determine the range are very short—of the order of mil-

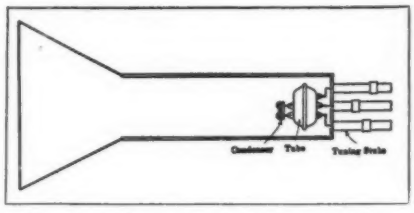


Fig. 3. Position of tube in transmitter.

lionths of a second. Time intervals of this duration can be measured only by unusual electronic circuits. In fact, the accuracy with which the time is measured determines the accuracy of the range. Consequently to obtain a range accuracy of three yards, time must be

measured to an accuracy of a hundred-millionth of a second. If the time is measured to this accuracy then the range is accurate to within 3 yards, irrespective of whether the range is 30 yards or 30,000. This is in contrast to the optical range finder which has a constant percentage error in determining the range.

This time measurement can be accomplished in two ways—either by varying the wave length (or frequency) at a predetermined rate or by sending out pulses of microwave energy. The altimeter uses the former method, but many radars today use the latter because it is possible to send out pulses of very high energy for a short period of time, thereby obtaining far greater energy in the transmitted signal than is possible by the frequency-modulation method.

High power in the transmitted pulse is required because the received signal which is reflected from the located object varies inversely with the fourth power of the distance of the object from the radar. This means that every time the range is doubled the received energy returning to the radar is one-sixteenth of its former value. Such power requirements demand very special microwave transmitting tubes which can be overloaded for short periods of time and deliver many kilowatts during the pulse time.

The power in the transmitted signal can also be increased by making the antenna more highly directive. The greater the directivity, that is, the less the angular beam width, the greater the power of the signal in the direction of

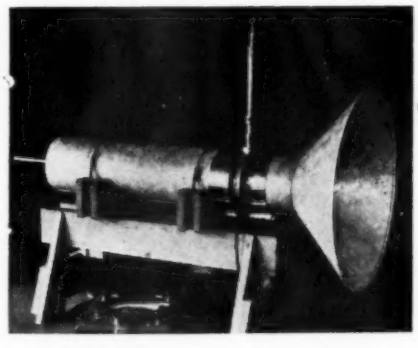


Fig. 4. The 20-cm. microwave receiver.

the beam. In the case of horn antennas, this can be accomplished by using horns of larger diameter, for the angular beam width or directivity is inversely proportional to the diameter of the horn, while the power is proportional to the square of the horn's diameter. Consequently, by use of high powers for extremely short periods (microseconds) and by means of directivity it is possible to receive a signal reflected from an object at 30,000 yards (17 miles) or more, in spite of the inverse fourth-power law.

Directivity is also very important because it means that the narrower the transmitted beam the more accurately one can locate the position of the target. Thus, to use radar in combat on land or sea it is necessary of course to be able to move the antenna about in all directions until the beam strikes a target.

TO make use of the information radar gives—namely, the position and range of the enemy target—other electronic devices are brought into use. An example of such an electronic device for use in directing antiaircraft fire is the Army's M9 gun director. The M9 receives from radar the position and range of the airplane and by means of electronic circuits predicts the airplane's course. Besides this information, that of projectile velocity, wind velocity, and other necessary corrections are added so that the director automatically controls the aiming of the antiaircraft guns. The effectiveness of this director has been described in a recent statement by Lieut. Gen. L. H. Campbell, Jr., Chief of Ordnance, as follows:

"In World War I we used to hit a plane, not knock it down, for every 17,000 rounds [of antiaircraft fire]. Today, these great men of ours are knocking down [a plane] on an average of ninety shots."

During the buzz-bomb attacks on London, the M9 gun director was most effective. Dr. C. A. Lovell of the Bell Telephone Laboratories, one of the physicists responsible for the M9 director, has said: "On one typical day, 143 flying bombs reached the coastline [of Britain]. Artillery [antiaircraft] bagged 65, the RAF got 35, the balloons brought down 17, and only 23 got through. Out of seven that came across in a single flight, the guns got five. When you consider that the target is traveling 350 to 450 miles an hour and is only 17 feet wide and that the range was, on the average, as far as from the Battery to the Empire State Building, that is really some shooting."

Radar is not only being used against enemy aircraft but is now used by our own aircraft against enemy shipping and installations, particularly in connection with precision bombing. The radar bombsight makes possible accurate bombing in any kind of weather in which bombers can fly. The target is located by the radar, and information as to range and position is transmitted to an electronic computer which also takes into account the speed and height

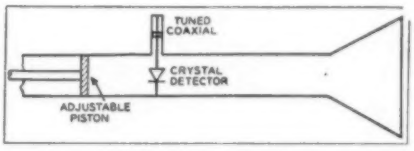


Fig. 5. Position of crystal in receiver.

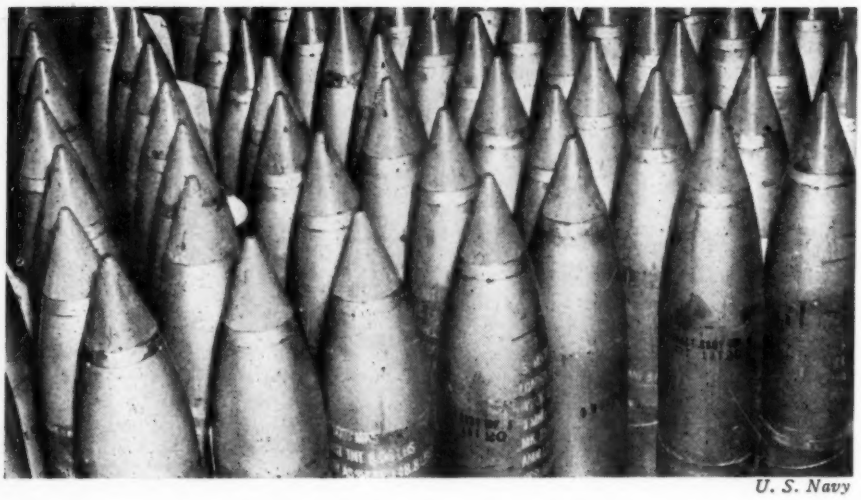
of the bomber. The results from the computer are used by the bombardier to release bombs at the proper time.

Besides these applications, radar is used to locate and find the range of enemy vessels at sea and to control the aiming of naval guns.

What of the future of radar? It seems that radars will be installed on every ship at sea, and probably on every tug and ferryboat in New York harbor after the war. They should prevent collisions in fog and accidents with icebergs and permit a ship to sail safely into any harbor in the world, irrespective of the weather. Similarly, airplanes should be able to fly over mountain ranges in storms without mishap, for their position above the mountains will be known at all times with a radio locator. With radar airplanes should be able to effect blind landings at any airport in bad weather, day or night, and should be able to avoid collisions with other aircraft.

IT has been said that the greatest service which radar has rendered in this war was in the Battle of Britain when the Royal Air Force knocked out the *Luftwaffe*. The British were well equipped with radar stations which located the German bombers as soon as they took off from the airfields of France so that their positions could be mapped. This enabled the RAF to be at the proper place at the proper time when the German bombers arrived. The rest of the story is well known—it was the turning point of the war.

Since then radar has stood guard at many danger points along United Nations' frontiers and at sea, warning of the coming of aërial and sea-borne forces and contributing toward victory in combat. The new science has played a vital part in helping first to stem and then to turn the tide of Axis conquest.



U. S. Navy

Rockets for Aircraft

Higher Velocity and a Faster Rate of Fire Are the Principal Problems.

Louis Bruchiss

THE construction of war rockets and their use as infantry and aircraft weapons have already been described in ARMY ORDNANCE by Lieut. Col. L. U. Bailey (March-April 1945, p. 233) under the title "Rockets for War," and by Col. L. A. Skinner (September-October 1944, p. 261) in "Birth of the Bazooka." It will be the purpose of this article to analyze the latest tactical use of aircraft rockets and to indicate what the future possibilities are as based upon present technical requirements and trends.

A study of the various types of aircraft which we operate shows all too clearly that the rocket is not meant as a defensive aircraft weapon. To date it has been mounted only on fighters, fighter bombers, and medium bombers, always as an auxiliary weapon to fixed machine guns and cannon and used solely in air-to-ground attacks. The Germans have been the only ones to try air-to-air rocket launching, with meager results.

The aircraft rocket, due not so much to weight as to size, has been carried in limited quantities only. Early practice had been to mount six rockets—now increased to ten—in clusters of three under each wing. The theory is that if these rockets are well aimed and one or more hit the target, their mission has been accomplished. These targets are invariably those which require the explosive power of the equivalent of a 4- to 5-inch shell to be reduced.

The requirements of aircraft gunfire are many, but most important among them is rate of fire. For any type of combat mission, airplanes must be able to operate their weapons at the highest rate technically obtainable. A high rate is not yet possible with rockets because so few can be carried. An obvious remedy would be to make them smaller in size, somewhat like the 2.36-inch bazooka type, and fire them automatically like cannon shells.

Early rocket projectiles had either fixed stabilizing fins or hinged fins which opened after the rocket had been launched from its tube, as the M8. The latest 4.5-inch rocket has no fins and appears in a streamlined shell form. Stability is obtained through rotation of the rocket by means of multiple propulsion nozzles in the rocket motor which are graduated in size. This development, carried somewhat further, eventually may provide the answer to high-speed accurate rocket fire from aircraft.

In an attempt to solve the problem of ultrahigh-speed automatic gunfire, the author, in his book "Aircraft Armament," discussed the possibility of using separate-loading small-arms ammunition, finned for stability so that it could be fired through nonrifled barrels. However, this still would not eliminate gun weight and recoil.

While it is true that a rocket of any size would carry less explosive charge than a complete round of cannon shell of similar size, because the rocket must carry its own propulsive motor and fuel, it is equally true that the weight of a gun and a recoil-resistant mounting is entirely dispensed with.

One complete round of 20-mm. shell weighs about one pound. It is conceivable that smaller rockets than the 2.36-inch type could be made. The latter, as a means of comparison, weigh 3.5-pounds each. The weight of a launching tube is insignificant, amounting to but a few pounds. If rockets are to be used in air-to-air offensive and defensive combat, it is evident that automatic feeding and firing means must approach those used in automatic recoil-type guns.

The matter of range and of velocity is also important. In conventional ballistics, the trajectories of bullets and shells are based upon their known muzzle velocity, and then the other factors of drag, gravity, drift, and atmospheric differences are calculated so that they can be corrected by computing instruments or observed fire.

In rockets, the initial velocity may be lower than that of rounds fired from rifled barrels, but the trajectory is more easily calculated because of the constant velocity rate. True, the weight of the rocket decreases as the propellent fuel is consumed, but even this could be corrected for by automatic regulation of the burning rate or of the nozzle aperture size. Under such conditions, a trajectory might be perfectly straight, if desired.

THE disadvantage of low over-all velocity is the time required to hit the target. In air combat, the possibility that enemy aircraft will have changed speed, course, or direction must be considered, and once it is known that low-velocity ammunition is being fired, it can be expected that such maneuvers will be adopted.

The loss of velocity of caliber .50 bullets and automatic cannon shell is rather high at the longer ranges, and there may exist conditions where hits from these shells would be readily turned by armor plate. This would not

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be true of any target that would be struck with a rocket velocity equal to that of the starting tube or higher. An interesting fact about rockets is that higher velocities may be obtained in flight or at predetermined ranges by adjusting the rate of fuel burning. This is not possible with rifled bullets and shells.

The advantages of stability rotation for regular shells would be lost at extreme altitudes where a near vacuum exists. There also the fins of rocket projectiles would be useless, but the nozzle-imparted rotation types would be even more effective since rotation would be as constant as the velocity. This brings up the pertinent question of where most air-to-air combat is likely to take place.

As air warfare stands today, the largest aircraft are merely huge bomb transports. Defensive armament has been standardized around a limited number of caliber .50 machine guns in remotely controlled turrets with automatic instrument control of fire. It has been found that the caliber .50 machine gun, with its high cyclic firing rate of 600-800 rounds a minute, was the optimum weapon to be used against enemy fighters.

Our superbombers, and those to come later, will undoubtedly seek the highest altitudes in which they are capable of operating in order to escape detection, observation, and antiaircraft fire from the ground. These craft present rather large target areas and so would be more vulnerable to automatic gunfire from enemy fighters than a small maneuverable fighter. Similarly, the larger the target, the more advantageous it would be to direct rockets at it, if these rockets can be fired in sufficient volume.

From the standpoint of our main-effort bombing technique in the war against Japan, air action will take place at extreme altitudes. However, there is nothing in the book that prohibits construction of superbombers with jet-propulsion engines, in which case ceiling and speed would be further enhanced. This is not likely for the next few years, within which time we hope to have vanquished our remaining enemy.

If high-altitude combat is to be the principal order of the day, rockets are more in their element. Their low velocity in the atmosphere due to heavy nose drag would be eliminated. Rotation, as has been stated, would be automatically provided for. Observation of fire would be relatively simple, since each rocket has a visible exhaust jet. Sighting and fire-control instruments for rocket defense from heavy bombers would be less complicated than present computing gun sights. The elements which must enter into calculations would include, however, time of flight to target, relative speed and direction of target, and blowback from the ship firing the rockets. Such rocket fire control should be very accurate for long-range firing.

On the other hand, it is not to be assumed that air fighting will take place only at high altitudes. The Japs have been attacking our shipping and ground positions of all kinds with every type of plane in their possession. They come down to minimum flight levels in many cases, and our fighters are often forced to follow them down to these low altitudes in order to intercept them and shoot them out of action. The necessity for such action has been accentuated by the fact that the Japs have initiated suicide tactics. Under these conditions, every effort, however desperate, is being made by our own fighters to get these aircraft before they even approach our vital targets.

AMONG these suicide attempts have been piloted flying bombs, which are, of course, nothing more than airplanes built for a single specific mission—that of carrying the heaviest possible bomb load with the highest possible speed to any important target, such as a naval vessel, a large ammunition dump, or a military base.

It is the job of air intelligence, through air reconnaissance and other means, to determine the source of these attempts, to chart the general form of attack, and then to have our fighters ferret them out at the source. If they can be detected only while under way, our fighters must intercept them at the farthest point from the target. This will mean flying and fighting at almost every altitude. Again, it must truthfully be said that at the moment high-speed and high-volume machine-gun and cannon fire seems best suited to hit these elusive, fleeting, dangerous Jap targets.

Rockets can only be employed against these particular aircraft if the total cyclic rate of fire from any one airplane is brought up to that now attainable with machine guns. A possibility exists that a greater number of launching tubes could be emplaced on a plane—up to thirty or more, instead of ten as at present. If relatively low-speed firing then took place from each tube, the firing might be spaced consecutively, and the total fire would still amount to a sufficiently high cyclic rate to assure hits upon a fast aërial target.

With 30 tubes, each tube would only have to deliver 100 rounds a minute in order to equal the firing rate of 6 machine guns at 500 rounds a minute. The score would then be heavily on the side of the rockets because of the terrific firepower which a 3,000-rounds-per-minute rocket battery could deliver. Naturally, the quantity of rocket ammunition that could be carried would limit the duration of this firepower to a matter of seconds.

If enough ammunition for, say, one minute's firing for six machine guns could be carried by a specific airplane, to which must be added the weight of the guns and mountings, only a proportionate weight of rockets and rocket tubes could be carried by the same plane.

On the basis of the weights of a caliber .50 cartridge (¼-pound) and that of a 2.36-inch rocket (3½ pounds), if the latter is to be used in our comparison, only about 5 seconds of total fire would be available from the rocket battery. Second for second, however, the weight and effectiveness of fire from the rockets would be greater, since the total rate of fire is the same as for the six machine guns, and each round of rocket ammunition, if it hits the target, may be capable of destroying or at least seriously damaging it. There remains on the debit side, of course, the lower velocity and greater time of flight of the rockets to the target. This would result in a decreased number of hits compared with machine-gun fire.

Thus it will be seen that the whole field of aircraft rockets, as it applies in air-to-air combat, is subject to exhaustive analysis and interpretation when compared with known and proved existing weapons. More precise results will be available only after actual experimental development and tests of new high-velocity rockets and high-rate launchers.

Decorations of the U.S. Army

The United States Army has always recognized deeds of high valor on the battlefield and exceptionally meritorious service both in peace and in war by officers, enlisted men, and civilians. This recognition is marked by the award of decorations and service medals, by battlefield promotions, by written commendations, and by an increase in the monthly pay of enlisted men who merit certain awards for heroism or for proficiency.

1. MEDAL OF HONOR (1862).—To Army officers and men for battle gallantry at risk of life beyond call of duty.

3. DISTINGUISHED SERVICE MEDAL (1918).—To Army personnel for exceptional service in duty of great responsibility.

5. SILVER STAR MEDAL (1918).—To Army personnel for gallantry in action not warranting the Medal of Honor or DSC.

7. SOLDIERS' MEDAL (1926).—To military personnel for heroism, voluntary risk of life, not in combat.

9. AIR MEDAL (1942).—To Army personnel for meritorious achievement while participating in aerial flight.

11. GOOD CONDUCT MEDAL (1941).—To Army enlisted personnel for exemplary behavior, efficiency, fidelity.

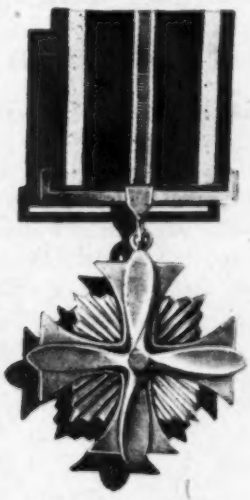
13. TYPHUS COMMISSION MEDAL (1942).—To military personnel or civilians for meritorious service in typhus control.

For heroism and achievement

Illustrated on these pages are some of the principal decorations awarded by the War Department. The medals are shown in their order of precedence and are followed in parentheses by the dates of their institution. "Army personnel" in the captions includes officers, men, and civilians serving with the Army; "military personnel" includes officers and men only. Certain decorations may be awarded to members of Allied forces.

2. DISTINGUISHED SERVICE CROSS (1918).—To Army personnel for extraordinary heroism in action against the enemy.

4. LEGION OF MERIT (1942).—To military personnel for exceptionally meritorious conduct in outstanding service.



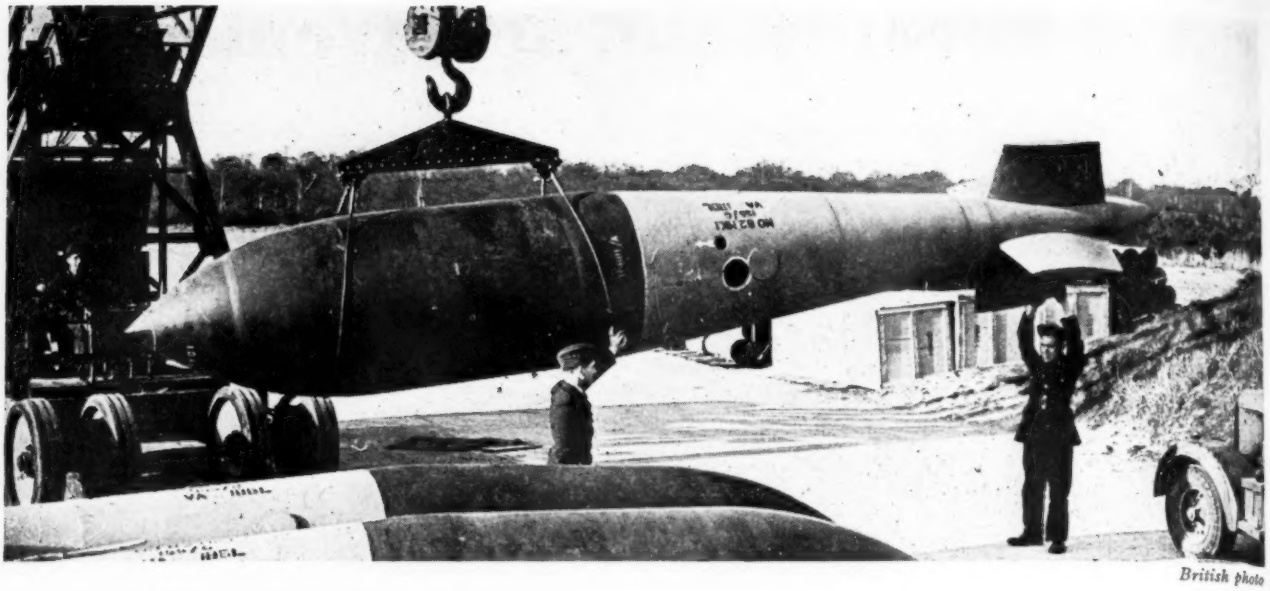
6. DISTINGUISHED FLYING CROSS (1926). To AAF military personnel for heroism or extraordinary achievement in flight.

8. BRONZE STAR MEDAL (1944).—To Army personnel for heroic achievement or meritorious service, not in flight.

10. PURPLE HEART (1782).—To Army personnel wounded in combat, if treatment was required by a medical officer.

12. MEDAL FOR MERIT (1942).—To civilians for exceptionally meritorious service. (Counterpart of Legion of Merit.)

14. AMERICAN DEFENSE SERVICE MEDAL (1942).—To military personnel who served a year or more between Sept. 8, 1939 and Dec. 7, 1941.



British photo

The Earthquake Bomb

Irresistible 6-ton Missile of the RAF

Col. Harry Scullin and Col. Clyde H. Morgan

The story of a 12,000-pound weapon that may be but the forerunner of greater and greater aërial demolition bombs.

THE huge bomb that sank the German superbattleship TIRPITZ, broke the back of the enemy submarine pens at Brest, and created tidal waves in hostile waters was the result of the vision, courage, and tenacity of one man—a blind man.

Air Comdr. Patrick Huskinson had joined the Royal Flying Corps (now RAF) in the early days of World War I. A pioneer of aërial combat, he was completing twenty-eight years of service in those tragic days of 1940 when the RAF fought to the bitter end that their nation might live. In the midst of a Nazi blitz to obliterate London, Commodore Huskinson was struck down. He was blinded by bomb fragments, and the doctors despaired of restoring his sight. Commended for his valiant services, he was placed upon the retired list to pass his remaining days in total darkness.

The period of enforced idleness while recuperating from his injuries provided a valuable opportunity for introspection and undisturbed thought. Undoubtedly it served to stimulate the clear foresight and vision with which nature had so generously endowed him. Lying on his hospital cot, he foresaw the use to which the Nazi warlords would put their newly acquired seaports and bases on the English Channel and the coast of France. He foresaw swarms of U-boats darting out from concrete nests to prey upon the vital shipping so essential to Britain's existence. Probably he appraised the German efforts to construct a battleship so powerful that it could destroy any other vessel afloat. Possibly he also visualized the buzz bombs, the rocket bombs, and even the multigunned batteries by which the enemy planned the reduction of London and of all England to formless heaps of rubble.

By the spring of 1942 Commodore Huskinson knew the time was growing late, terribly late, if an effective answer to the German threat was to be developed. At this time he returned to his country's services, unofficially, devoting his full energy to the development of bigger and more powerful bombs for the RAF to drop on German targets. With the invention of the highly accurate bombsight there was an obvious need for a bomb capable of greater damage—a bomb which would obliterate, not crumble, the target.

His thought was to replace a multitude of smaller bombs with a single unit of such tremendous power that complete elimination of the target would result. Rapidly in sequence he processed the 2,000-pound bomb, then one of 4,000 pounds, succeeded by the 8,000-pound bomb. Finally he achieved the goal of a 12,000-pound "earthquake" bomb. In each step, new and varied problems were encountered and successively overcome. These involved fuzes, simultaneous detonation of charge, and ignition problems. When Air Chief Marshal Sir Arthur Harris, chief of the Bomber Command, first announced the use of the 6-ton devastator, he described it as "the most destructive air weapon ever used." (The British later also employed the 22,000-pound aërial bomb shown above, very similar to the 6-tonner.—ED. NOTE.)

THE rising crisis of the submarine attack dictated the initial employment of this weapon against the heavily fortified submarine nests along the Euro-

Colonel Scullin is chairman of the board, Scullin Steel Company, St. Louis, Mo.; Colonel Morgan is chief of the St. Louis Ordnance District.

pean coast. British Intelligence had discovered that Brest, Lorient, and other havens along the French and Norwegian coasts had been developed to refuel, repair, and supply the vast Nazi fleet of underwater prowlers protected by steel and concrete walls ranging from twelve to fifteen feet in thickness. These U-boat pens appeared virtually impregnable from aërial assault. The United States had entered the war following the vicious attack on Pearl Harbor. Help was available and would soon be forthcoming, provided this U-boat menace could be definitely and permanently removed.

Huge RAF Lancaster bombers carried the new earthquake bombs for the first time to Brest. Complete extent of the damage they wrought was not verified until the French seaport fell to the allies in September 1944. Then the truth became known. Four of the new "earthquakes" had penetrated through twelve feet of steel and concrete to explode inside, leaving openings as large as forty feet in diameter. Great holes were blown in the roof of three of the submarine shelters. Photographs from the interior showed steel reënforcement bars hanging like spaghetti from the rims of the openings made in the roof. Yet at the time the earthquake bombs were introduced, no bomb then in use was acknowledged to have even a chance of penetrating such heavy protection.

During this period the German Navy finally completed the most massive warship then known. The powerfully gunned TIRPITZ, estimated as of nearly 50,000 gross tons, had been placed in operation. It had been conceived as a 1-ship fleet capable of overpowering any vessels which it could bring into range of its weapons. The menace of this great floating fortress and the possibility of its becoming loose to shatter the Atlantic sea lanes of supply caused many sleepless nights in the British Admiralty building in London. The TIRPITZ obviously constituted the next and most imperative employment for the earthquake bomb.

In September 1943 the TIRPITZ had been detected hiding out in the fjords near the northwestern tip of Norway. From this location there was an imminent threat of interruption of vital supply lanes and the possibility of frequent sorties resulting in piecemeal destruction of the British fleet. Initially, midget subs were dispatched and cautiously crept through fifty dangerous miles of water to torpedo the TIRPITZ, resulting in severe underwater damage. By the time repairs were effected the ship was again immobilized by bomb damage which resulted from an attack in April 1944 by Barracuda naval bombers. Finally the RAF was ready to apply a permanent solution.

In September a squadron was launched against the TIRPITZ armed with earthquake bombs. The effect of this attack is well known. Several of the bombs achieved direct hits and others exploded adjacent to the hull. The TIRPITZ was sunk with a loss of more than 1,000 lives.

Now the RAF was free to concentrate on the imminent menace of the robot-bomb installations along the Channel coast. These secret-weapon emplacements were to continue as the final objective for earthquake bombs until the closing of the war. At St.-Leu Desserant hundreds of Nazi robot bombs were stored in the limestone caves. One Huskinson earthquake bomb penetrated the hill above the caves, collapsing them as though they had been struck in fact by an earthquake. An area the size of three American football fields showed the devastating effects of the 6-tonner. Other type bombs would have left a mark resembling a saucerlike crater in the hill.

Nazi long-range weapons emplaced in a quarry at Wizerne were rendered harmless by a single 12,000-pounder. At the end of the quarry was a cliff on the top of which stood a domelike structure erected for added protection. Only one "earthquake" on this spot pulled the whole face of the cliff into the quarry.

In the 6-ton bomb, for the first time, tremendous penetrating power is combined with deadly blast effect. It penetrates deep into its target when dropped even from medium altitudes. It contains the heaviest possible charge of explosives and achieves an extremely high terminal velocity. It is equipped with a delayed-action fuze and a thicker casing; therefore it does not explode until just inside or under the target.

Enemy ships in enclosed harbors and tidal basins were destroyed by artificial tidal waves created by the 6-ton bombs. Gouging craters 40 feet deep and 110 feet in diameter, near misses from the giant bombs were often found to cause greater destruction than direct hits. After one such "tidal-wave" raid, reconnaissance photographs showed that out of twenty vessels, only a tank landing craft and six auxiliaries were left intact. Additional targets were dams, sea walls, and industrial cities in Germany and occupied France. At the U-boat pens in Ijmuiden, the entire cement backwall was ripped out by a single earthquake bomb.

WHEN design of the earthquake bomb was completed in August 1943, a search was made in the United States for a facility to handle mass production of the item. Requirements included a plant with proper equipment, personnel with requisite technical knowledge, and management sufficiently resourceful and daring to try the unknown. Specifications for the bomb were brought to this country by British ordnance representatives and presented to the Scullin Steel Company of St. Louis, Mo., for detailed analysis. In little more than two months the first model was completed. This proved so satisfactory that within four days, following rigid inspection and examination, a regular production schedule was under way. By the end of the year quantity shipments were on their way to the loading plants for dispatch to the RAF.

The bombs are cast of high-alloy steel in the plant foundry by a special technique which maintains the required close tolerance of 0.15-inch without necessity for external machining. The savings in cost and man power so achieved have been a material factor in meeting production schedules while reducing the over-all cost price by nearly forty per cent. After heat-treating and stress relief, the bombs are subjected to individual X-ray and hydraulic-pressure tests. The nose and tail are machined to provide for multiple-fuze installation to avoid any possibility of failure.

The earthquake bomb has not yet been used against our Pacific foe, but the day of retribution is coming. Until now the land of Hirohito has only been singed on the surface. The time will soon arrive when those islands will rock as though a thousand Fujiyamas were erupting in all directions. The Jap may seek protection by burrowing deeper and deeper into the ground but the big bombs will follow—he cannot escape!

AAF-International

The Shooting Star

Lockheed's P-80 Jet-Propelled Plane

Tony LeVier

THE day is clear, the air is solid. Under the stick the P-80 Shooting Star seems almost alive. At 10,000 feet she streaks along at unbelievable speed. Then, nose to the field and almost before I can set myself for the run, she screams across the strip like a runaway ghost. A couple of easy rolls and she's right back up there.

It's my biggest thrill in ten years around hot airplanes. I'm not exaggerating when I say I literally can feel the gooseflesh rise on my forearms. But to make this picture clear I should explain that I'm not flying the plane. I'm standing on the ground watching it. That's where you get your thrills from the P-80.

Although the Lockheed Shooting Star is the fastest airplane the world has ever known, you lose your sense of speed when you're actually in the cockpit. You realize you're really traveling, all right. But it's hard actually to feel your terrific momentum. The roar of your jet-propulsion power unit never catches up with you. It's so quiet you can hear yourself snap your fingers.

Even though you're prepared for the unusual, the first time up in a P-80 leaves you flabbergasted. The reaction shown by pilots after their first Shooting Star flight is comical. Bewilderment is about the only word for what they display. I've seen lots of pilots take lots of new planes up for the first time. But none of them ever came down in the frame of mind that the P-80 puts you in.

The case of Jim White is typical. Jim is one of those "born" fliers you hear about—one of the top-notch test pilots in this country today. But he will never get over his first flight in the Shooting Star.

Jim took off that day like a scared hornet, and he never slowed down during his entire flight. He buzzed the field at a speed that only a few other men in this world have ever attained, flipped around on the tip of one wing and came back even faster. He climbed, dived, and rolled like a madman. Then, with the daintiness of a ballerina, he set her down.

Jim had put on a show that left all of us—even our seasoned pilots—talking to ourselves without shame. But when he stepped from the cockpit he looked really sheepish. "Thought I'd better take it sort of easy the first time up," was all he had to say.

We who had already flown the Shooting Star knew exactly what Jim was thinking. He actually didn't realize what a show he had put on because things were so quiet in the cockpit.

A pilot like Jim, of course, normally knows exactly what his plane is doing every minute he's up there. But the Shooting Star honestly had him confused. He couldn't believe that his maneuvers had been more than moderately spectacular.

ANOTHER good Lockheed test pilot who was fooled from the ground up on his first P-80 flight is Herman (Fish) Salmon. At present Fish is making final preparations before doing additional dive tests on the plane. But at that time all he knew about flying a jet job was hearsay.

Fish gave his P-80 the gun on takeoff and sped down the field. Faster and faster he went, but with three-quarters of his runway gone he still wasn't airborne. There wasn't a one of us watching Fish that day who wasn't unconsciously pulling his stick back for him. He had only a couple of hundred yards to spare when he finally pointed the plane's nose skyward and whooshed out of sight.

We learned later that Fish was as scared as we were. He was watching the end of the field coming up fast. But he couldn't believe he had flying speed until he looked down at his instruments. His speed was about twice what he thought it was. It was at this point that we saw the plane take off—but fast!

When a plane fools you like that on the ground you can imagine what it does to you in the air.

I recount these instances because I think they will give a clearer idea of how radically different the Shooting Star is—it had to be to fill the Army's stringent requirements for a fighter that would outclass any plane in the world. For years our engineers have known that as the P-38 Lightning and other first-line fighters proved their superiority over Axis planes they were reaching their zenith in performance.

To get another ten or twenty miles an hour top speed or another few hundred feet of maximum altitude in a reciprocating-engined plane, aircraft engineers have had to design a completely new ship. It was obvious that if they were to make any major performance advancements in aircraft they would have to take a totally new approach to aërodynamic design and principles of propulsive power.

Jet propulsion was the logical answer. As far back as 1941 Lockheed had submitted a design for a jet-propelled fighter to the Army but was asked to delay the project to permit concentration on production of urgently needed conventional planes.

Mr. LeVier is chief engineering test pilot for the Lockheed Aircraft Corporation, Burbank, Calif.

Within two years, however, the necessity for a superfighter of jet design had become so urgent the Air Technical Service Command presented Lockheed with drawings of a British jet engine and asked that a suitable airframe be built around it at the earliest possible moment.

The story of how Clarence L. (we call him "Kelly") Johnson, 35-year-old Lockheed engineer, designed and built the first Shooting Star in 143 days would make a feature article in itself. Kelly and the boys working under him set a record for design and production never before achieved in aviation history. They pushed the P-80 across the drawing boards, through their emergency canvas and packing-box hangar, and into the sky in about a third of the time it normally takes to develop even a conventional ship.

There followed a year of continual flying in a secret program of testing and refinement. Capt. Wallace Lien, who initiated the Army test schedule in February 1944, broke existing American speed records before the average citizen was aware that there was such a thing as a jet-propelled plane. In February 1945 the Shooting Star was announced by the Army as perfected for combat. Today it is being produced on a rapidly accelerated program.

THE perfected Shooting Star carries a General Electric engine instead of the British power unit used on the first experimental plane. It is the most powerful aircraft engine in the world. It burns fuel similar to kerosene that has a higher BTU rating than high-test gasoline. But the P-80 could operate with high efficiency on practically any low-grade combustible with no flame, glow, or telltale stream of smoke emerging from the jet nozzle.

The P-80 is without doubt the "cleanest" airplane ever to take the air. In addition to the plane's low drag, the comparatively light weight of the G-E jet engine also adds to maximum range. With the weight saved through its power unit alone, the ship can carry extra fuel in an ingenious arrangement of fuselage and wing tanks (see illustration on p. 250). The P-80 has a speed in excess of 550 miles an hour and a service ceiling of more than 45,000 feet.

Pilots, mechanics, and manufacturers agree that one of the P-80's outstanding advantages over conventional planes is simplicity of design. Absence of the conventional fighter's propeller, carburetor, generators, ignition system, oil system, radiators, air scoops, and all the complex controls for these items makes the P-80 exceptionally simple to build, service, repair, and fly.

Without propellers the plane hugs the ground on a short, light landing gear which permits mechanics to service it without use of ladders or platforms. A complete change of power unit can be made in less than fifteen minutes. And the power unit, although more powerful than any reciprocating aircraft engine ever built, has less than a tenth as many moving parts.

As a result of its simplicity the P-80 is extremely easy to fly. A single lever regulates power for acceleration and deacceleration, and by use of that single lever the pilot gets one hundred per cent efficiency of operation. If he doesn't, his engine isn't running at all.

No need to say how much this means to the combat pilot. I know, from dozens of talks with combat pilots, that many have entered battle with a plane performing far below normal because one of a dozen or so engine adjustments wasn't made properly. But they are the lucky ones. They're the ones that got back to talk about it.

That's why the P-80 gives a pilot an added sense of security. You climb into your cockpit, start your engine, and in thirty seconds—no matter how hot or how cold the weather—you've got full, controlled power with the push of one lever.

Armament of the Shooting Star is located in the nose for most effective concentration of firepower. Guns shoot parallel streams of bullets and are equally effective throughout their entire range. Unlike wing-mounted guns, they do not need to be fired at specific ranges to get the most effective concentration of projectiles.

Another item that puts the P-80 head and shoulders above other planes is comfort. For the first time our engineers have designed pilot comfort right into an airplane. The bubble cockpit is located ahead of the wing for perfect visibility. The cockpit itself is completely pressurized and extremely comfortable in appointments. Standard equipment includes an attachment for G-suits to lessen discomfort and danger of blackout in tight turns and pullouts.

LINES of the Shooting Star are the smoothest of any plane I've ever seen. The knife-like leading edge on the wing, the sleek, glasslike negative gray finish, and the over-all rhythm of wing, fuselage, and empennage give it the appearance of terrific speed even on the ground. The P-80 has a 39-foot wingspan, is 34 feet 6 inches in length, and its total loaded weight is approximately 14,000 pounds.

And performance is in harmony with appearance. Hydraulic aileron boosters and balanced empennage controls give the P-80 the fastest roll of any plane in the world. Rate and angle of climb are superlative. Control forces are unusually light, even at high speeds.

The jet-propelled P-80 Shooting Star is a daring design brought forth by the demands of a fast-moving war. But it is already exerting a tremendous influence on the design of planes now being planned for peacetime operation. America has led the world in the field of jet propulsion in war. I think it will continue to do so in peace.

The fact that Germany had jet-propelled planes in battle for several months does not prove superiority in aircraft development. German jet planes were largely experimental. Weak in armament and short in range, the Nazis' jet planes were put into the air with the idea of placing every available weapon into the final defense effort. The Shooting Star was kept under cover until perfected.

Now, prospects of the new jet and jet-turbine power in adaptations to all types of aircraft—transports and private planes as well as fighters—are definitely past the dream stage. The Shooting Star has proved already that jet performance is far superior to anything ever achieved with reciprocating-type engines.

While many details of this airplane are still restricted for security reasons, it is obvious from Mr. LeVier's brief description that the Shooting Star is something new in aircraft. Built as a fighter to outclass any plane in the world, there can be no doubt that it is but the forerunner of even more revolutionary developments aloft—both military and civilian.

ORDNANCE ROLL OF HONOR

THE following two Ordnance officers have recently been decorated for distinguished service:

MAJ. GEN. THOMAS J. HAYES, Falls Church, Va., has been awarded the Distinguished Service Medal "for rendering distinguished service from June 1942 to March 1945 as chief of the Industrial Service, Ordnance Department. He was responsible for the development of an immense nation-wide procurement and production organization."

General Hayes

General Harris

General Hayes also received the Legion of Merit "for services from July 1941 to March 1942 as director of the Production Branch in the Office of the Under Secretary of War. He supervised the successful accomplishment of the War Department procurement program covering all military equipment and supplies."

MAJ. GEN. CHARLES T. HARRIS, JR., Mexia, Tex., has been awarded the Distinguished Service Medal (Oak Leaf Cluster) "for exceptionally meritorious and distinguished service to the United States Government in a position of great responsibility in directing all procurement and production activities of the Ordnance Department, United States Army, as chief of its Industrial Service. His skill, industry, and broad experience in the administration of the Ordnance manufacturing functions enabled the prompt and efficient operation of the largest military armament production program in the history of the world."

General Woodberry

General MacMorland

THE following Ordnance officers and enlisted men have been awarded the Legion of Merit:

BRIG. GEN. EDWARD E. MACMORLAND (then Lieut. Col.), Alexandria, Va.—"For service in the Office of the Under Secretary of War from September 8, 1939, to August 13, 1941. As chief of the Procurement Planning Division, Planning Branch, with unusual foresight and intelligent comprehension of the magnitude of the task and the difficulties likely to be encountered, he took prompt and decisive action to make effective policies which would insure the acquisition of adequate and necessary supplies."

BRIG. GEN. JOHN H. WOODBERRY (then Col.), Washington, D. C.—"For exceptionally meritorious conduct in the performance of outstanding services in the Southwest Pacific area from November 1944 to February 1945. As Chief Ordnance Officer, U. S. Army Services of Supply, General Woodberry planned and established a reclamation and repair program for military combat and transport vehicles and developed standardized maintenance methods."

COL. MERLE H. DAVIS, Burlington, Vt. —As Deputy Chief Ordnance Officer of the U. S. Army Forces in the Western Pacific, Colonel Davis developed planned, balanced loads, selection discharge, and ammunition resupply ships for amphibious operations now institutions of that theater. He also took the lead in creating a new knowledge of the tropical storage of ammunition. There were no precedents, and peacetime storage experience was not sufficient to chart the way.

COL. KENNEDY HASSENZAHL, Westport, Conn.—"For exceptionally meritorious conduct in the performance of outstanding service as a commanding officer of the Chinese Ordnance Training Center during the period September 15, 1944, to February 15, 1945." (Photograph by Underwood & Underwood, Washington, D. C.)

Colonel Davis

Colonel Hassenzahl

COL. JAMES E. B. MCINERNEY, Washington, D. C.—"While serving in the Office of the Chief of Ordnance and at Aberdeen Proving Ground from September 1939 to March 1945, through his broad practical and technical knowledge and tireless effort he developed the application of welding to mass-production methods in the manufacture of tanks and other combat vehicles."

COL. HORACE A. QUINN, Falls Church, Va.—"For services in the de-

Colonel McInerney

Colonel Quinn

Colonel Toftoy Colonel Seleen

velopment, testing, and standardization of the 75-mm. cannon for aircraft. His achievements, at great personal risk, in the development, testing, and standardization of the 75-mm. aircraft cannon constitute an outstanding contribution to the war effort."

COL. PAUL M. SELEEN, Arlington, Va.—"As chief of the Ordnance Department International Division from September 1939 to March 1945, he directed the entire Ordnance Lend-Lease program which in 4 years provided $9,000,000,000 in Ordnance supplies to 43 friendly foreign nations. His superior performance in a position of high responsibility was a vitally important contribution to the success of the allied war effort."

COL. HOLGER N. TOFTOY, Phoebus, Va.—"For exceptionally meritorious conduct in the elimination of mine fields that hampered the landing of troops and ships during the invasion of the European Continent. Subsequent to D-day, Colonel Toftoy conducted the investigation of controlled mine fields in the harbor at Cherbourg."

COL. THEODORE A. WEYHER, Washington, D. C.—"For service from July 1940 to March 1945 as chief of the Carriage Branch, Artillery Division, Industrial Service, Office, Chief of Ordnance. The vision, technical skill, and good judgment displayed by this officer in the supervision of designs, selection of manufacturing facilities, and close production follow-up made possible the timely rearmament of our troops with 155-mm. howitzers, 4.5-inch guns, 8-inch guns, and 240-mm. howitzers of superior types."

COL. FERDINAND M. HUMPHRIES (then Lieut. Col.), Hawesville, Ky.—"For service while alternate to the War Department General Staff representative on the Munitions Assignments Committee (Ground) from June 13, 1942, to November 2, 1943. He was empowered to make binding decisions for the General Staff which he did continuously. As chief, plans and projects subsection in the Operations Division, from November 3, 1943, to December 15, 1944, he was responsible for action upon all operational projects submitted to the General Staff."

MAJ. PAUL S. BLANDFORD, JR., Surry, Va.—"For exceptionally meritorious conduct in the performance of outstanding services on the Fifth Army front in northern Italy. Serving in the capacity of supervisor of ammunition storage and ammunition supply-point operations on the Anzio beachhead, Major Blandford developed the 'bunker system' of ammunition storage and the exploiting of fire-fighting equipment to combat ammunition fires."

STAFF SGT. JOSEPH C. BRYAN, Long Island City, N. Y.—"While on duty as an inspector in the maintenance shop, Ordnance Depot, Erie Proving Ground, Lacarne, Ohio, from August 1944 to March 1945, he displayed ingenuity and inventive genius by designing and constructing on his own initiative and without assistance a device for testing top-carriage wiring on 40-mm. guns."

Colonel Humphries Colonel Weyher

THE following Ordnance officers and enlisted men have been awarded the Bronze Star Medal:

LIEUT. COL. HARVEY RIVKINS, Baltimore, Md.—"For meritorious service in connection with military operations as chief of the Public Relations Branch, Office of the Chief Ordnance Officer, European Theater of Operations, from April to October 1944. Colonel Rivkins showed extraordinary initiative and efficiency in his public-relations work." He also was recently awarded the French Croix de guerre.

LIEUT. COL. DONALD M. SIMPSON, Huntingdon, Pa.—"For meritorious service in direct support of military operations from May 20, 1944, to April 25, 1945. Colonel Simpson performed the duties of division Ordnance officer in an extraordinary manner. By his exceptional knowledge of Ordnance supply, his knowledge of bombs and fuzes, and of transportation, together with his initiative and untiring effort, Colonel Simpson enabled his command to set an outstanding record for medium bombardment aircraft."

Colonel Simpson Colonel Rivkins

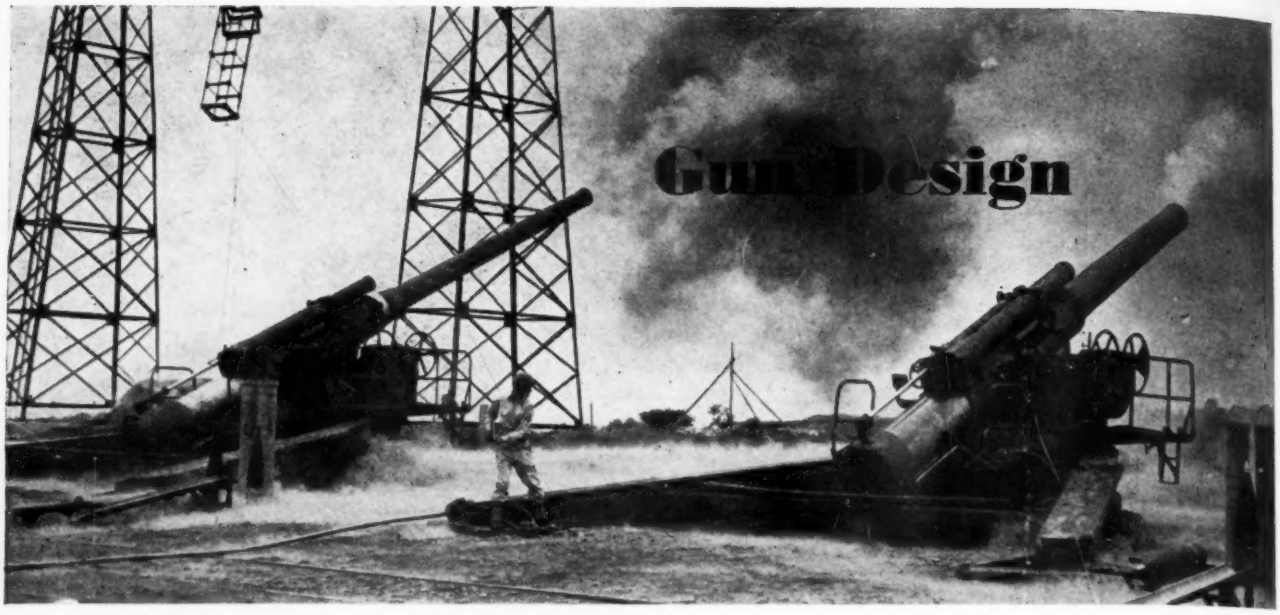
CAPT. WILLIAM R. MICHAEL (then 1st Lieut.), Newport, R. I.—"As officer in charge of a team of automotive experts in India from October 1 to November 30, 1944, he was mainly responsible for the prompt shipment by air of a large number of motor vehicles, including F3 refueling units, from India to Burma and China."

CAPT. HARRY P. QUINN, Bridgeport, Conn.—"For meritorious service in direct support of military operations from August 13, 1944 to April 25, 1945. Captain Quinn, by his skill and willingness to put forth every effort, accomplished the work as ammunition officer in an outstanding manner."

TECH. SGT. DARREL S. WELTY, Williamsport, Pa.—"For meritorious services in support of combat operations in North Africa and Italy."

TECH. 3RD GRADE WILLIAM J. BOYDSTUN, Dayton, Tex.—"For meritorious achievement during the Philippine campaign from November 1, 1944 to April 28, 1945."

Captain Michael Captain Quinn



Acme

Principles and Practices of Arms Development

Lieut. Col. G. L. Cox

WHILE it is well known that guns fire projectiles at high velocities and that, to develop these high velocities, high pressures generated by burning powder are employed, probably not so well known are the factors that have to be considered in designing the gun, how they are arrived at, evaluated, and translated into metal strength requirements.

Gun designers over many years have developed experience and a backlog of practical, as well as empirical, relationships that permit them to accomplish with a reasonable degree of assurance of success a layout that will attain the military requirements of the piece. Many principles are the same as they have been for years, yet with the advent of newer weapons, where velocities are increased with concurrent decrease in weight, new concepts and factors have to be considered.

The particular bore size (caliber), tube shape, length, etc., are the characteristics of a gun that are usually arrived at as a result of military requirements and Ordnance research and development. With reference to the first, there may come from the using arms a requirement for a certain caliber and velocity with a certain type of projectile to accomplish certain specific purposes or desired advantages over existing guns of our own or those of the enemy. Such advantages include greater armor penetration, flatter trajectory, longer range, shorter time of flight of projectile, lighter weight, greater simplicity of operation, etc.

Research and development are, fundamentally, the very existence of the gun designer. He not only attempts to translate into a gun what the using arm wants, but he also is constantly alert to new capabilities and tries to keep well ahead of actual requirements. Many of the models developed by armament engineers never see a battle, but the knowledge and experience gained through their development serve as the foundation for other models where the designer may benefit from his own or others' mistakes.

The design and development of a gun usually start with the ammunition. Military requirements will generally involve muzzle energy and some other features that more or less fix the weight, caliber, and type of the projectile. The designer goes to the ballistician for aid in the selection of the chamber or cartridge-case size and the expected powder pressure, to serve as the basis for the thickness of the tube over the chamber. When he chooses, from other considerations to be discussed later, the strength of the steel, he can then place a dimension on the tube at this point.

There are several well-known types of gun-tube construction. The principal ones are monobloc, heat-treated or cold-worked to strength; multisection, with replaceable loose liner; built-up, with shrunk-fit sections or hoops; and wire-wrapped. Currently, the U. S. favors the monobloc type of gun for the light to medium caliber and the multisection, built-up gun for the large calibers. Where material shortages are more acute than man power, the replaceable loose-liner guns are indicated for even medium calibers because the gun may be renewed by the use of a new liner.

Research and development are, fundamentally, the very existence of the gun designer. He not only attempts to translate into a gun what the using arm wants, but he also is constantly alert to new capabilities and tries to keep well ahead of actual requirements.

CONSIDERABLY more machine hours are required to make the loose-liner or built-up guns, and as long as steel supply and heat-treating facilities are ample, the monobloc is likely to be used for light to medium caliber guns. Wire wrapping is an old art, and yet such guns are still in use. With the avail-

Colonel Cox is chief of the Cannon Branch, Artillery Development Division, Research and Development Service, Office of the Chief of Ordnance.

ability of high-strength steels, it is more economical to use heat-treatment, cold-working, or shrinking as a means of obtaining strength. In its day, the technique of wire wrapping was as revolutionary as some current armament developments.

AUTOFRETTAGE, or cold-working, of guns is done to incorporate favorable residual stresses at the bore. Guns have been cold-worked in this country since the early 1920's when Watertown Arsenal designed the containers and cold-worked forgings for 75-mm. and 3-inch guns. Since then, tubes or liners of numerous calibers of guns and howitzers have been cold-worked in regular production. Autofrettage is accomplished by expanding the rough-machined gun tube by means of internally applied hydrostatic pressure, sufficient to cause permanent enlargement of the bore.

Plastic deformation, thereby occurring, increases the yield strength of the steel by an amount predictable from the stress-strain curve of the material, and, most importantly, the residual stresses left in the metal at the bore of the gun are in compression. These compressive stresses may be used in the design strength of the gun. As the propellent gas tends to expand the gun, it must neutralize the compressive stresses before it can start stretching the steel.

The dimensioning of a gun tube is a relatively simple procedure once the designer has the formula in front of him. In sections as thick as gun tubes, the stresses acting at the bore have vectors in more than one direction. In order to evaluate these and arrive at an algebraic expression that constitutes a condition of yielding of the tube under the pressure of propellent gases, the vectors must be combined. The theory or concept of combining these stresses is not simple. Over a period of years several concepts have been proposed, all of which probably only approximate the true stress conditions but which, nevertheless, have formed the basis of design of guns that have performed satisfactorily in service.

Practically, the specific theory used will reflect in the actual value of the apparent factor of safety. Without giving the derivations, the three formulas shown in Table 1 are applicable to gun design. The maximum strain theory (1) has been used in the past by most gun designers. The distortion-energy theory (2) is more recent and is believed to be the one that best fits the actual conditions of stressing of the complete section of a heavy wall tube. The maximum shear theory (3) is believed to be representative of the condition of the very first deformation of the metal at the bore and is, thus, the most conservative theory.

1. Maximum Strain Theory:

$$Y = \frac{2}{3}\left[\frac{P}{W^2 - 1}\right]\left[2W^2 + 1\right]$$

2. Distortion-Energy Theory:

$$Y = \left[\frac{P}{W^2 - 1}\right]\sqrt{3W^4 + 1}$$

3. Maximum Shear Theory:

$$Y = \left[\frac{P}{W^2 - 1}\right]\left[2W^2 \quad\right]$$

Where, in all, Y = stress at which yielding occurs, p.s.i.; P = internal pressure, p.s.i.; W = wall ratio of tube; *i.e.*,

$$\frac{\text{outside diameter}}{\text{inside diameter}}$$

Table 1. Formulas used in gun design.

TO make his job easier, the gun designer will usually develop a set of curves showing on the ordinate "pressure factor" (internal pressure over yield strength of the matériel) and on the abscissa, "wall ratio" (outside diameter over inside diameter). Thus at any section of the tube where wall ratio and powder pressure are known, the elastic strength can be computed. Yield strength measured at 0.01 per cent offset is very close to the commonly accepted elastic limit. The elastic limit of steel may be defined as the highest point of stress at which the metal will return to its original shape and dimension when the stress has been removed. Figure 1 shows this sort of curve for the distortion-energy theory for guns made from either cold-worked forgings or those heat-treated to strength.

Powder pressure is the one factor that the gun tube is built around and must withstand. The more accurately the powder pressure is known, the more certain is ultimate design.

In only comparatively recent years has research on gun design considered radial pressures developed by the rotating band of the projectile with a view toward their evaluation and inclusion in design concepts. Techniques have been developed for measuring these pressures, and in some designs of guns band pressures are apt to be as high as the powder pressure, or even higher. The magnitude of band pressures is dependent upon such factors as the amount of interference between the band and the bore of the gun, the fit of the band on the projectile, the type of projectile (solid shot give higher band pressures than high-explosive shell, because the hollow shell is more resilient), the ease at which the band can be engraved, and others of perhaps less importance.

All designs for strength of guns are prefaced on the tube being smoothbore. While it has been known for a long time that the rifling does impose added demand upon the steel, the magnitude is not precisely known. New methods of testing, such as photoelastic procedures, extremely short gage length strain gages, "stress coat," and X-ray diffraction, make it possible to estimate fairly the intensity of concentration of stresses at the junctions of lands and grooves.

By current concepts and, in general, where the lands and grooves are comparable in width and where fillets are reasonably generous, it may be considered that rifling has the effect of concentrating stresses to the extent of: width of land plus width of groove divided by width of groove. The effect of such stress raisers is to subject the metal in the vicinity of the fillet to stresses possibly higher than the yield strength of the steel. Deformation may take place or a crack may form, especially if the stress exceeds the fracture strength of the steel. Fracture strength differs from tensile strength in that it is the true strength or load divided by actual cross section at the time the specimen breaks. Tensile strength, on the other hand, is the maximum load reached in the tensile test, divided by the original cross-sectional area of the specimen.

Gun tubes in service are subjected to fatigue as a result of cyclic application of stress counted by the number of rounds fired. It is not fatigue in the conventional sense. Ordinary fatigue of metals is in terms of millions of cycle, whereas fatigue in guns is in terms of thousands of cycles (rounds fired). To distinguish between ordinary fatigue and the comparable destructive effect in guns, recent considerations have caused the selection of the term "progressive stress-damage." That term is a good one because it is explicit and tells exactly what happens.

The quantitative extent of progressive stress-damage in guns, or the number of cycles the tube will require for failure, is dependent upon two principal factors: (1) the level of stress in the metal at the bore surface, including any concentration of these stresses, and (2) the resistance of the steel to the propagation of the cracks that may form in highly stressed regions through the wall to a point where the remaining section will no longer withstand the powder pressure.

IN the conventional gun, the tube may wear out from erosion faster than the advance of progressive stress-damage. In fact, in some guns it may be difficult to observe any effects of this phenomenon because erosion obscures it. Thin-wall, high-pressure guns stressed near the proportional limit of the section can be expected to be more subject to progressive stress-damage than the heavier, more conventional guns.

Erosion is not wear in the common sense. It is the result of a combination of simple wear, the scouring action of rapidly moving, extremely hot gases (very dense because of their compression), and heat oxidation and other chemical effects of the metal. Guns start to wear or erode on the first round fired. The amount is dependent almost entirely upon quantity and temperature of the powder gases. The principal detrimental effect of wear is the loss in muzzle velocity of the gun, with consequent loss in range and striking power.

While the gun designer can do very little about erosion *per se,* he does constantly search for means to prolong the life of the tubes. Such means as protective coatings in the bore, insertion of liners of either more resistant materials or easily replaceable ones of steel, and cooling the gun have been tried with variable success.

The breech ring is used for securing the gun tube and forms an assembly or unit in which the breechblock or breech mechanism is operated. The breech ring is provided with lugs or other facilities (*e.g.,* locking rings) for attachment to the recoil system of the carriage. The ring itself must be in harmony with the gun. While it is not subjected to such effects as erosion or band pressures, it is susceptible to all other factors that must be considered in the design of the tube, including stress concentrations, fatigue, shock, etc. The gun designer is cognizant of these and, aside

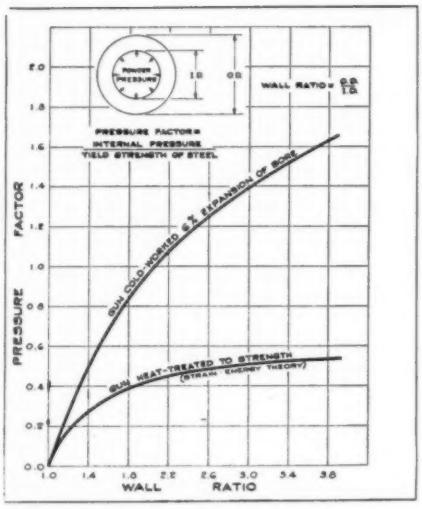


Fig. 1. Pressure factor vs. wall ratio.

from selecting material of adequate strength and toughness, he is generous with radii of fillets.

To fire a gun, a firing mechanism is necessary that will at the right time drive a striker (firing pin) against and detonate the primer, which in turn actuates the igniter and the propellent charge. The mechanism, therefore, is designed to produce the initial actuating force and at the same time provide for sealing the gun against the pressures developed by the main powder charge. Firing mechanisms are, in general, rather complicated devices due to safety-feature requirements, and a great amount of tedious and detailed designs and pilot models constitute their development.

The designer must recognize the necessity for adequate strength of all parts, fewness of parts for simplicity, ease of manufacture, close tolerances, provision for wear surfaces, and, above all, ease of operation and foolproof functioning. Misfires are a tremendous handicap to a planned program of artillery fire. There is perhaps no other essential part of a gun that is as sensitive to operation or as demoralizing if operation fails as a firing mechanism.

The design of muzzle brakes to reduce recoil energy is the function of the gun designer in close coördination with the carriage designer. The reduction of thirty to fifty per cent in recoil force permits the carriage designer to lighten the over-all weight of the carriage or use the weight more profitably in other places.

Research has shown that stresses and their rate of application in brakes are high; consequently the designer must devote the same care to their design as to the other, perhaps more vital, parts of the gun or mechanism. Steels, section thickness, and baffle spacing and clearance must be carefully chosen, and weight is most important. Carriages that are not designed for guns with muzzle brakes may require rebalancing or remodeling of equilibrators to counteract the excessive "muzzle preponderance."

High-quality steel in guns has always been essential, and the more recent concepts have made it even more important. As indicated previously, gun tubes, liners, and other vital parts are, for reasons of weight saving, designed with minimum factors of safety. Ordnance standards therefore have included methods of quality control and improved inspection procedures to see that the desired quality is maintained.

In simple tensile properties, elongation and reduction of area of the steel are useful to the gun designer, but for certain highly stressed guns he must have more. In thin-walled guns, made from high-yield-strength materials, where factors of safety are even lower than in conventional guns and where rates of strain and band pressures are high, stress-raisers present, and low temperatures of service encountered, the designer must have the added assurance of inherent toughness of the steel. This toughness is indicated by means of notched-bar impact tests, such as the Charpy or Izod. Extended endurance firing programs on thin-walled guns have shown, consistently, that steel corresponding to the "tough" variety is required for adequate performance.

THE yield strength of steel is the primary basis on which the dimension of the gun tube, breech ring, block, or other part is determined to withstand the pressure developed by the propellent gases. This is the property that must be met in the forging. The gun designer must have the assurance of the metallurgist, the inspector, and the manufacturer that the steel in the forging will at least meet the minimum yield strength he shows on his drawing.

In thin guns, where progressive stress-damage is an especially important factor, it is perhaps safer for the steel to have a yield strength close to the minimum used in the design; therefore the designer is interested in the range of yield strength being kept as small as is consistent with the best forging and heat-treating shop practice.

The Atomic Bomb

A New Weapon of Tremendous Power and Possibilities

THE atomic bomb which President Truman announced was dropped on the Japanese city of Hiroshima at 9:15 A.M. on August 5th was the bomb heard 'round the world. According to data available as this issue goes to press it is a master weapon, as revolutionary in its implications as the discovery of gunpowder, and one that may well change the face of modern warfare and of civilization itself.

The tremendous power of the new bomb may be judged from the statements of Mr. Truman and Secretary of War Stimson, from the results of the first test of the missile, and from the disclosures of Army reconnaissance and the Japanese themselves after the actual bombing which culminated in the enemy surrender offer.

"The atomic bomb," the President said, "is a harnessing of the basic power of the universe. The force from which the sun draws its power has been loosed against those who brought war to the Far East . . . That bomb had more power than 20,000 tons of TNT." Secretary Stimson said the bomb "has an explosive force such as to stagger the imagination."

In the first test of the bomb in a New Mexico desert 120 miles from Albuquerque, a huge cloud of smoke, dust, and fire billowed 40,000 feet into the sky in 5 minutes. The blast knocked down 2 observers nearly 6 miles away and rattled windows more than 250 miles distant. Forest rangers as far as 175 miles from the site felt the shock and thought there had been an earthquake. The steel tower from which the bomb was dropped by remote control was completely vaporized.

Army air reconnaissance, hampered for some time by the huge cloud of dust and smoke over Hiroshima, finally reported that 4.1 square miles or 60 per cent of the city was "wiped out" and additional damage done. The Japanese themselves stated that "every living thing" in the entire city of normally 343,000 inhabitants was completely destroyed. Those outdoors were "seared by fire," they reported, while those inside died from the terrific heat and pressure caused by the explosion.

At the present stage of development, uranium is the element essential to the production of the atomic bomb. Principal sources of uranium are in Canada, where a pilot manufacturing plant is being built, and in the Belgian Congo. There are also deposits of pitchblende and carnotite, from which the white metal is extracted, in the United States, Austria, England, Russia, Norway, and Sweden. German scientists, however, who were hot on the trail of applied atomic fission, were evidently using "heavy water" (deuterium) as a source, and Commando and AAF raids on the huge plant at Rjukan, Norway, in 1942 and 1943 destroyed enemy supplies of this substance.

MR. CHURCHILL SAID:

"This revelation of the secrets of nature, long mercifully withheld from man, should arouse the most solemn reflections in the mind and conscience of every human being capable of comprehension. We must indeed pray that these awful agencies will be made to conduce to peace among the nations and that, instead of wreaking measureless havoc upon the entire globe, they may become a perennial fountain of world prosperity."

THE chain of discoveries culminating in the atomic bomb began at the turn of the century with the discovery of radioactivity. Until 1939, work in this field was carried on throughout the world, particularly in the United States, the United Kingdom, Germany, France, Italy, and Denmark. In that year President Roosevelt appointed a committee to examine the possibilities of applying atomic energy to military uses, and in 1941 the project was put under the direction of a group of eminent American scientists in the Office of Scientific Research and Development, headed by Dr. Vannevar Bush.

In 1942 President Roosevelt appointed a General Policy Group which recommended great expansion of the work and transfer of a major portion to the War Department. Maj. Gen. Leslie R. Groves was placed in executive charge of the project. To consider the purely military aspects of atomic energy, the General Policy Group appointed a Military Policy Committee.

Despite many unsolved problems, in December 1942 it was decided to proceed with the construction of large-scale plants. Two of these are at the Clinton Engineer Works in Tennessee, and a third is at the Hanford Engineer Works in the State of Washington. A special technical laboratory is located in an isolated area near Santa Fe, N. M., under the direction of Dr. Robert J. Oppenheimer, principal developer of the new bomb. The project cost $2,000,000,000 and once employed 125,000 persons, now 65,000.

In August 1943 a Combined Policy Committee was formed, including members from the United States, the United Kingdom, and Canada, to bring the project to fruition as quickly as possible. With the approval of the President, Secretary Stimson has now appointed an Interim Committee charged with the responsibility of formulating recommendations to the President concerning the postwar organization that should be established to direct and control the future course of the United States, both with regard to the research and developmental aspects of the entire atomic-energy field and to its military applications. This committee will also recommend regarding problems of both national and international control.

Of the future possibilities or limitations of the atomic bomb, little can be written at this time. Its penetrative qualities, application to naval and aërial warfare, and the use of its explosive substance in shells and rockets must be disclosures of the future. A clue is given, however, in Secretary Stimson's words: "Improvements will be forthcoming shortly which will increase by severalfold the present effectiveness. But more important for the long-range implications of this new weapon is the possibility that another scale of magnitude will be evolved after considerable research and development."

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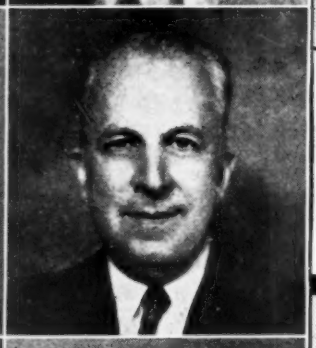

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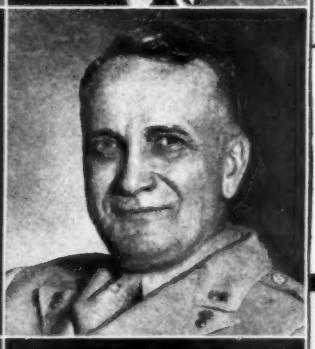

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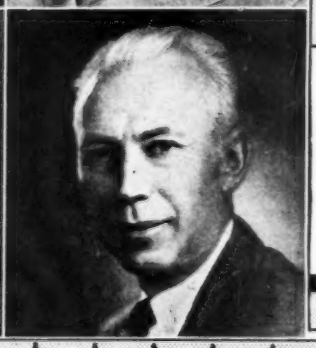

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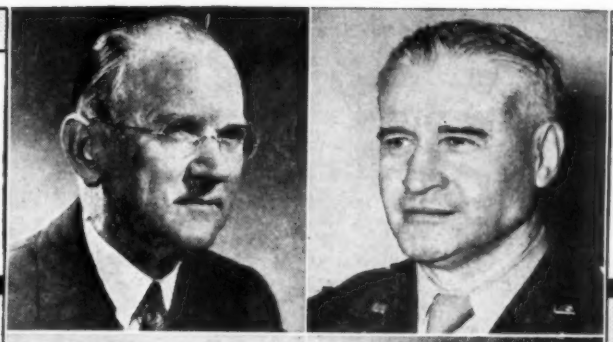
These Industry-Ordnance Leaders



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Training Enlisted Specialists

How the Ordnance School Developed Skilled Mechanics

Capt. J. G. Smithwick

World War II with its many types of new matériel necessitated replacing the general Ordnance mechanic with the trained specialist. The need for shortening instruction time also was a factor in the Ordnance Department's decision to teach its maintenance men specialized techniques rather than give them the longer general course. The success of the Ordnance School and civilian institutions in fulfilling this program is amply attested by the success of our arms in battle on every front.

THERE was a time—and not too long ago—that a country doctor with his little black satchel was the one indispensable man in his community. Frequently referred to as a "general practitioner," he was called upon to cure everything from insomnia to gout. He readily admitted that certain ailments were beyond his capability and would advise his patient to see a "specialist."

In the early months of the war in Europe, when the urgent needs of the battle front were pressing training installations for time, the Ordnance School was turning out "Ordnance country doctors." These men, too, were indispensable in their theaters of operations, and though they did not carry black satchels, they were prepared to heal the wounds of all types of battle-damaged Ordnance matériel.

An enlisted man, a graduate of the Ordnance School automotive course, for example, would be called upon to service all types of automotive equipment and would be expected to know as much about fuel induction as about automotive electricity. The demand for large numbers of school-trained technicians in a relatively short period of time gradually brought about greater specialization. The introduction of many new items of matériel added to the need for replacing the general mechanic with the specialist. This trend of specialization was evident not only in automotive training but in all technical training in ordnance. In reviewing the schooling of enlisted men at the Ordnance School from 1941 to 1945, it is interesting to note this prevailing tendency toward specialized training.

The training of Ordnance enlisted men began several years prior to the present war when the Ordnance School was located at Raritan Arsenal, Metuchen, N. J. At that time training was concentrated on broadening the technical knowledge of Ordnance noncommissioned officers. It was the practice of the Ordnance Department to draw a portion of its enlisted personnel from men who had served several years in other arms and services. These men had proved their general ability but had little ordnance knowledge. They found at the Ordnance School a small officer complement and a small number of experienced noncommissioned officers—and they found a nine months' course.

The product of this training was a mature enlisted leader who proudly assumed the title and responsibilities of an Ordnance sergeant. His technical knowledge was sufficiently broad to enable him to accept a position of responsibility in analyzing and testing matériel; to become a post Ordnance sergeant, in which capacity he might be the most experienced Ordnanceman at his post and a potent figure in peacetime Army supply; or to become a maintenance-shop foreman. Such training was possible because of high prerequisites, long training, an experienced staff of instructors, ample equipment and facilities for the number to be trained, and stable (peacetime) training problems.

THE move of the school to Aberdeen Proving Ground, Md., in 1941, was occasioned by the need for expanded training facilities. The problems confronting the school during 1941, 1942, and 1943, relating both to training management and enlisted specialist training, were the general problems common to the Army as a whole and to industry.

This period of transition—from peace to war—called for conversion from training for peacetime Ordnance garrison duties to training for wartime field duties. Larger training establishments were needed for the heavy influx of students. Time was critical—new items of matériel were in production, and Ordnancemen were urgently needed to maintain this equipment the moment it was issued to the fighting troops. Multiplying the output of school-trained technicians necessitated considerable changes in the training technique, among the most important of which was the development of specialized courses of instruction.

In the essential requirement that men be trained for wartime field duty, the Army was immeasurably aided by the existence and rapid expansion of the Army classification system. This system establishes military occupational specialties consisting of the job title (*e.g.*, machinist), a specification serial number (114), and a job description which itemizes the principal duties the machinist may be called upon to perform.

The value of such a system is self-evident. From the training standpoint, the job description serves as a statement of the objective of training in each course, and the field commander knows what the graduate of a school course should be able to do when assigned to a unit under his control. The addition of new military occupational specialties has kept pace with the development of new types of matériel.

A fortunate aspect of the enormous training requirement in the early phases of the war was the high priority that training establishments were given in the selection and expansion of their trainer personnel. This was essential because the parent schools were required to furnish cadres of qualified instruc-

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tors for the many new training establishments which sprang into existence throughout the country. Military Plans and Training Service, Office of the Chief of Ordnance, alone operated fifty-eight schools and training centers from coast to coast.

The experienced noncommissioned instructors of the prewar days were for the most part called to active duty as Ordnance officers or were early applicants for officer-candidate training. They were replaced by the steadily growing number of intelligent and enthusiastic young men who were inducted and given basic training at the Ordnance Replacement Training Center. Through the extensive use of training-methods instruction, these men rapidly developed into competent teachers, although the short period of time that could be afforded for their training required them to be specialized in limited fields of ordnance.

Instructor personnel from Ordnance training centers soon became the Ordnance Department's most dependable source of officer candidates because of the care originally exercised in their selection, their experience with training problems, and their concentration on self-development. Therefore the Ordnance School has always maintained a fairly rapid turnover of enlisted instructors.

A PRINCIPAL source of enlisted students for the Ordnance School has been the new inductees who receive basic military training at the Ordnance training centers at Aberdeen Proving Ground and at Flora, Miss. Selected personnel from these training centers have been sent to the school for technical training before being assigned to units in training in this country or transferred overseas to replace losses and augment service personnel abroad.

The second main source of students has been Ordnance personnel assigned to Army Ground Forces units. Most of these men receive preliminary training with the organizations to which they are assigned prior to entering the school. Upon the return of these men to their units they share their knowledge of proper maintenance and supply procedures with other men engaged in similar duties, and in this manner all personnel benefit to some degree from the training of the selected few.

Besides the demand for large numbers of trained technicians, the need to return students to their organizations quickly in order to meet readiness dates was another cause for greater specialization. By July 1942, courses at the school had been revised for this purpose. Where formerly in 1941 three 13-week automotive courses existed, in July 1942 eleven shorter specialized courses were being taught that covered the same general material. By April 1945 these eleven courses were consolidated into eight courses. This breakdown of automotive courses is an excellent illustration of increased specialization in training.

The constant requirement to add new matériel to all courses without increasing time length has caused a continual refinement in training methods. The pressure of necessity requires a steady inquiry into the essentiality of everything that is taught.

A training-methods instructor is detailed to work regularly with each instructional branch. He observes the instructor teaching his class in order to offer concrete suggestions for self-improvement and to upgrade instructors who are deserving. He also analyzes the teaching to detect learner difficulties and to help overcome them by suggesting new approaches. Along with a training-aid expert and a representative of the instructional branch, he reviews all training aids used in the course to determine where new aids can be used to advantage or existing ones improved.

The understanding of proper utilization of training aids, combined with the current refinement of course programs, has now reached the point where programs, instructor guides, and training aids can be dispatched to a new training installation along with competent trainer personnel and the course put into operation with a minimum of time loss and preparation.

The Ordnance School faced additional problems in 1944. The physical plant was complete, and, except for new items of matériel, adequate stocks of training equipment were on hand. However, the total number of enlisted specialists in training increased due to the closing of other training establishments and to special training requirements on new equipment. Concurrently it was necessary to release for overseas service the highly experienced staff of instructors which had been built up during the previous two years. Replacement instructors were obtained from personnel returning from overseas theaters and from those disqualified for transfer overseas. This replacement and the consequent need to emphasize instructor training occurred during the most active phase of enlisted training.

BEGINNING in 1942 the Ordnance School has trained in its Base Shop Division cadre personnel for assignment to base maintenance units. Enlisted men with previous school training or allied civilian background are placed in training with the base shop for 12-week periods on an apprentice basis. Working on fifth-echelon overhaul of equipment, they are assigned to crews and progress from a helper status to a position of greater responsibility as their training develops.

A major contribution to the training of enlisted specialists for the Ordnance Department was made by the manufacturers in the Midwest area during the period July 1942 to September 1944. The manufacturers established schools following doctrine prescribed by Military Plans and Training Service, Office of the Chief of Ordnance, and the Ordnance School. The new schools received the administrative assistance of officers detailed from the Ordnance School and the service commands. These schools trained several thousand Army and Navy personnel in the maintenance of automotive and artillery matériel.

In many cases the instruction included practice in the assembly of automotive equipment right on the assembly line, and in all cases the training was closely associated with the manufacturing plant. In addition, the manufacturing concerns made substantial contributions to the development of charts and other training aids and in the preparation of maintenance manuals used in instruction. This training was one expression of the coöperation between industry and Ordnance.

Though the Ordnance School has made great progress in its training program it is not content to rest on its laurels. The school continually strives to develop new training aids and techniques. The thoroughness of its training can only be measured by the outstanding accomplishments of its many enlisted specialist graduates. Their deeds speak louder than words.

Oran to Naples

The Story of an Ammunition Job Well Done

Capt. William G. Meade

"ALL ASHORE!" We adjusted our packs and moved down the gangplank to the dock at Mers-el-Kebir, just outside of Oran, the buildings of the town gleaming white in the hot November sun. We could see no evidence of the war in North Africa even though the city had been in allied hands less than a day; yet we knew that French snipers who had not heard of the capitulation the night before were still in the hills. Fifteen miles inland through these hills lay our destination where we were to set up our ammunition depot and have it in operation the following morning.

This was it! All our months of training and weeks of preparation had been building toward this day. As we formed our company on the wharf and looked up at the towering cliffs, the company commander and I had one question on our minds—"How well had the company been trained?" As its only officers during much of its training period after Pearl Harbor, we felt that we had done a good job of preparing the company for combat service. But could there be something that we had overlooked? We would soon know.

Our first fears of snipers were groundless, and we reached our assigned spot safely. Our new area was near a small village containing a large farm, a winery, some smaller farms, and vineyards. We moved our company into one of several small patches of woods on one of the farms. Although the main house on the large farm had been badly strafed two days before when planes observed some French soldiers moving through its barn and stable area, we found two usable buildings nearby. In these we set up our depot office, company supply, and company headquarters. A narrow-gauge railroad nearby was suitable for receiving or shipping ammunition and, at the same time, was a possible enemy air target. Most of the prospective storage area was absolutely devoid of cover.

As we planned our ammunition area we thought of our noncommissioned officers and their extensive training in depot operation and layout. Although we had lost thirty-five of our best men through admission to officer-candidate schools and by physical reclassification at the staging area, we thought we still had a good, smooth-working team. We had most of the lower-ranking men who had been sent to ammunition school at Savanna, Ill., and these were potential NCO's as well as trained ammunition specialists.

We realized only too well that many of the real answers to our training problems would come only now. Our men had worked with far too little live ammunition to make them proficient in ammunition identification. Three to four field problems a month with sand-loaded containers and the trucks of two Quartermaster companies in training at the same post had furnished excellent, but only dry-run, training in security, bivouac, movement, and depot layout. Only active operations would furnish the quantities of live ammunition necessary to complete the company's training. We were thankful that the company had spent four weeks in Northern Ireland operating a large depot prior to our departure for North Africa.

In Northern Ireland we had operated this depot during the loading for what we knew only as "a new and secret operation." All the ammunition was marked for various task forces prior to the loading, but we knew nothing of who composed these task forces or where they were to go. Many of our instructions led us to conflicting conclusions as to our particular destination. As an example, we had been issued mosquito bars and dust respirators and yet did not turn in our four blankets or overcoats.

At Oran we received some of the ammunition which we had loaded in Ireland and much of the reserve ammunition from the initial assault waves which was also on the ships. Since early collapse of French resistance had changed the original plans, this unneeded ammunition was not given its usual unloading priority. These ships were now waiting to be unloaded as quickly as possible so they could sail. Every day they remained made them a more likely target for long-range German bombers and increased the possibilities of meeting submarines on the return voyage.

We had expected considerable air activity, and, although surprised by its complete absence, we still carried out all passive-defense measures. Our ammunition area lacked cover, but we dispersed our stacks well, pyramiding them to avoid sharp shadows. Our men dug slit trenches as protection against a possible air raid. Then, with the harbor full of ships, the *Luftwaffe* struck. Damage was slight, but the town's anti-aircraft defenses got a thorough workout. From our area we had a perfect view of the thousands of tracers floating lazily through the black sky. We doubted that we would have appreciated the display had we been the target!

As the new front developed in Tunisia, we began shipping urgently needed ammunition there by rail. Adding this new task to that of receiving ammunition from the docks and keeping both jobs going at top speed was too much for the organic personnel of our ammunition company; it became necessary to augment our handling capacity with native labor. Instead of being merely a laborer in a loading crew, each soldier now found himself in charge of a group of Arabs.

AMMUNITION specialists and leaders were now our big need. The excellent noncommissioned officers previously mentioned were not enough; every man had to be thoroughly proficient. Fortunately we had men of sufficiently high caliber to command the Arab "squads." To control and direct their activities required a good knowledge of ammunition and a maximum of individual responsibility and initiative.

These desired qualities of leadership and self-sufficiency developed rapidly among our lower-ranking soldiers, and their technical background broadened correspondingly. They put all their energy and spirit into the tremendous task that had to be done. Each man

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was made to feel a personal responsibility for his part in supplying vital and critical material to the troops where it could be used against the enemy to greatest advantage.

We had the help of about 250 natives, having hired some 400 men originally to get these 250 as permanent workers. The pay was high for that locality, ranging from eight cents an hour for the day laborer, to twenty-eight cents an hour for the night foreman. They were organized into groups of eight or ten under a native subforeman. Most of them were Arabs, although some were poor Frenchmen or Spaniards attracted by the relatively excellent pay. The latter were good workers and often served as subforemen. Some of the workers spoke Arabic only, while others spoke Arabic plus French or Spanish. Very few spoke all three. In spite of language difficulties, we obtained considerable benefit from them.

OUR initial armored thrust across North Africa had been turned back just short of the gates of Tunis, and British and American forces were dug in awaiting the arrival of supplies and good weather to return to the offensive. The company left for this new battle front early in December, leaving a small detachment to operate the depot and continue the shipment of ammunition forward until they could be relieved conveniently. Ten days later they left Oran to rejoin the rest of the company in the heavy mud of Souk-el-Arba. It was here, rather than at Oran, that our operations directly behind the combat troops were to begin and the effectiveness of our training was to be tested to the limit.

We had to learn aircraft identification during the first week of operation. Enemy air activity was brisk, for our planes were often grounded by the weather and mud, while German planes operated freely from permanent fields with concrete runways. Ability at instant identification proved good life insurance, for on the second day six planes appeared over our area just as our men were lined up for the noon meal. Several of the men remarked what a comfort it was to see our Spitfires in the sky. At that instant the "Spitfires" began to dive-bomb and strafe the airfield just down the road. Our chow line vanished!

Although we had many excellent views of air raids such as the one at Oran, we now had the feeling that we were always a potential, profitable target. No longer was our defense entirely passive; we had drawn extra machine guns and kept them ready for action at all times. Our vehicles carried guns on improvised mounts. All through our operation of many ammunition supply points (ASP's) throughout Tunisia we never lost this feeling of eternal vigilance.

For six months after the first group left Oran we never had the entire company together at one time. The initial break-through at Faid Pass in February 1943 found us operating four ASP's. The Americans were forced to abandon considerable ground in southern Tunisia, and three of our ASP's were in the territory relinquished to the enemy. The installation at Feriana was cleared of its ammunition in a minimum of time without incident or excitement. The evacuation of our second ASP was completed just as the Germans began to drop shells in what had been the storage area. Our third ASP at Sbeitla was overrun before any effort could be made to move the ammunition to the rear.

Demolition of an entire installation was something that we had considered in training but never in terms of the actual detailed tasks and the time involved. The danger to the Sbeitla ASP became apparent only when the retreating troops passing to the rear and the sounds of battle coming closer indicated that the enemy's advance was unchecked. Communication with corps headquarters was impossible.

In the time remaining, the officer in charge acted on his own initiative and prepared the dump for destruction, mining what he could with TNT and scattering gasoline on the remains. He sent his men to the rear while he and two others stayed behind to light the fuzes and set fire to the gasoline. The last of this operation was completed just as the enemy tanks reached the edge of the olive grove where the ASP was located, but the *Panzers'* machine-gun fire failed to prevent our escape.

During the battle of Kasserine Pass we operated three new ammunition supply points in place of those recently evacuated. Two of these installations were prepared for demolition as soon as the German attack threatened to become a break-through. One of them was left with nothing but a demolition crew, while at Tebessa all available men and trucks were used to move part of the ammunition further to the rear. When news came of the German retreat, the TNT was quietly removed from the stacks, and ammunition reversed its flow into these ASP's to build up reserves for our next battle.

ON St. Patrick's Day the II Corps attacked, and a few days later we opened an ASP at Gafsa to supply the troops operating at El Guettar. Operating this ASP was a crucial test of the company's training and abilities. Air activity was intense. Ammunition was badly needed, and we had only one detachment to do the job of a company. In the last phase of the battle we were alerted for use as infantry to repulse a threatened local attack. It was during this local threat that we felt that more infantry training would have been desirable in spite of the security training and experience in the combat zone that we had had already.

Air reconnaissance had disclosed an enemy concentration which was potentially large enough to effect a break-through at a particular weak point on our flank. All the Ordnance troops in the vicinity were warned; maintenance companies readied the tanks and guns in their shops for action, and we drew extra weapons and set aside a quantity of ammunition. Then we waited. The attack, however, materialized at a strong point on the opposite flank, and by the next morning the enemy had withdrawn so far that our troops had lost contact.

During the waiting period many men had serious misgivings as to just what was in store for them. Enough additional training to have made them proficient in scouting, patrolling, infantry weapons, and small-unit tactics would

The war has long since passed from the shores of Africa and Italy but many stories of the heroism and backbreaking work that won victory for our arms in those areas are just being told. This is such a story. It shows how an untried Ordnance company added courage, sweat, and ingenuity to its technical training to solve problems that were not in the book.

have done much to raise each individual's self-confidence at such a time.

Operation of our ASP's by small detachments brought about the fullest possible development of our company and of each individual member. A sergeant or a corporal often found himself doing the job of a technical sergeant. Often we were forced to put a private or a private first class in charge of a bay or section, and just as often we were amazed at the excellent showing the man would make. A lesser performance on any one's part, however, would have seriously hampered the operations of our entire forces. Most of this ammunition was going right up to the guns and then into the enemy's positions, bringing all of us a step closer to victory. There could be no delays or wrong types issued!

Proficiency in ammunition identification was essential when issuing to the combat troops. The latter almost always brought their own labor, but a man was needed to take them to the proper loading point and to ascertain that the ammunition loaded was that called for by the loading chit. Since every man in the company was able to do this, there was never any delay in starting the loading and getting the troops on their way back to their units with the ammunition.

THIS same proficiency and knowledge of the ammunition area was also valuable when we received ammunition. In addition, our men often asked the drivers of the trucks delivering ammunition to help unload. The middle of an ammunition dump is not a healthy place if there is much air activity in the vicinity. Thus the drivers were usually very coöperative because they did not wish to linger in the area any longer than possible. If their coöperation was somewhat reluctant, it could often be stimulated by a follow-up man who would invent some tall story about the intense air activity of the night before. At Gafsa and several other spots the truth would serve the same purpose. In this way our men tried to solve our ever-present problem of insufficient labor during peak operation. Although only a partial solution, it was a direct approach aimed at the most handy labor source and was effective only because of the initiative and imagination of the individuals concerned.

At Gafsa we used this method of operation with maximum effectiveness. The town had the reputation of being a "hot spot," and at night there was usually an aircraft flare visible somewhere in the sky as the *Luftwaffe* night bombers searched for targets. We had a detachment of thirty-five men. Truck convoys of ammunition were arriving from the rear, fifty and one hundred trucks at a time. As this ammunition was badly needed at the front, the trucks were making as many round trips as possible.

Had we used six or seven squads of our own men to unload, we would have been hopelessly ineffective and the entire El Guettar battle would have slowed down while our trucks piled up. Instead, each man worked on his own, gathering three or four drivers together to get their particular trucks unloaded as fast as possible and on the way back for more ammunition. With each man feeling a personal responsibility for the battle then in progress, the entire crew worked thirty-six hours without rest. Finally the ammunition stock reached a safe level, and eventually more men from the rest of the company were sent to help.

Even with the addition of forty men to the detachment, the amount of ammunition to be handled kept every one working full time. When the II Corps moved to the north for the final phase of the campaign, we operated in much the same manner as we had at Gafsa. Ammunition expended in heavy-artillery barrages in the rough mountainous country kept our four ASP's operating on a continual emergency basis. To meet these sustained peak demands, additional labor was still obtained from the nearest available source—those soldiers who came to the ASP to deliver or draw ammunition.

Our labor problem was permanently solved when we moved to Italy. We became part of an ammunition battalion and were at once "issued" 200 hired Italian civilians. These men, taken with the company at all times, were paid eighty-seven cents a day, with thirty cents a day deducted for their food which was purchased locally. Food-buying was handled by the battalion, although in some special situations where local markets were favorable the individual companies of the battalion would buy food for their own laborers. We were not permitted to draw American rations for them, even to supplement the food purchased locally.

The Italians required two or three extra administrative officers in the battalion headquarters. One officer handled food purchases full time; another worked on clothing procurement in addition to other duties; and the third officer did nothing except attend to the payment of wages. With five scattered companies, it took one full day to pay the laborers at each, while on the sixth day this officer would balance his accounts and then go to the finance office for more money on the seventh day.

The discipline in the "Italian company" was semimilitary, inasmuch as it was made up mostly of ex-soldiers. The battalion commander prepared a tentative table of organization for these Italian labor companies to guide administration and operation. They had their own cooks, kitchen help, barbers, and carpenters, and functioned almost entirely under their own foremen—our soldiers exercising supervision wherever needed. These Italian units were the forerunners of the present Italian Service Units.

Without proper supervision, Italian labor would have offered no solution whatsoever to our long-standing labor problem. Every man who was a potential squad leader and who had taken charge of miscellaneous labor groups in the past now became the leader of an Italian squad of his own. Individual soldiers came to know the Italian foremen by always working in the area with the same Italians. Language difficulties were gradually overcome.

LOOKING over the company's progress I can see that its real power and growth did not come until each man developed an individual sense of responsibility and a definite knowledge of ammunition. This did not come until we began handling live ammunition and the men began to feel a pride and enthusiasm for their part in the war, although a few men had already developed this feeling during their training.

We were able to utilize additional labor and operate several installations at a time only because all our men were competent ammunition specialists. Future training of ammunition troops should be directed at producing as many of these specialists as possible. Upon such men may depend the fate of an army. From Oran to Naples they were our most valuable asset.

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Brig. Gen. R. H. Somers, Editor, 1942-1944

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SEPTEMBER-OCTOBER, 1945

Month by Month

A Department of National Defense?—Current discussions about the establishment of a Department of National Defense with the three natural subdivisions—land, sea, and air—are by no means new. They have been indulged in with more or less vehemence for the past twenty-five years. Experiences in the present war seem to make proponents of the idea more firm in their convictions and opponents equally certain that the present organizations are adequate as they are.

Land, sea, and air are zones of existence provided by nature. It follows that they are also media of warfare. Measured by any standard, each is big enough and important enough for a separate department with Cabinet representation. Development of airpower has emphasized the long-known importance of coöperation by all forces engaged in campaign and battle. History does not record any previous war in which a more effective coöperation between all branches of the fighting forces has been achieved. When the problem of coöperation was most difficult, the coöperation achieved was greatest.

But there are still things to be done to perfect this cooperation for the years ahead. A war college above all existing military schools is essential. It should consist of all arms—land, sea, and air. Combined operations should be its greatest concern. Also our Joint Chiefs of Staff organization is most effective and should be retained.

It is difficult to make even a guess as to how deeply the reorganization of the War Department will go. The long experience, accumulated knowledge, fine traditions, *esprit*, and the gigantic performance of the old services—Ordnance, Medical, Signal, Quartermaster, Engineer, Chemical Warfare—are assets that must not be lightly cast aside. We must look to the wisdom and experience of our leaders in these fields for the first move toward the new setup.

Generals Marshall, Eisenhower, MacArthur, Bradley, Devers, Stilwell, Patton, and a galaxy of others will have great weight with Congress. So will Admirals King, Halsey, Nimitz, Stark, and the rest. So also will Generals Arnold, Eaker, Spaatz, Wedemeyer, Doolittle, and others. These are the strategists, and their strategy is winning this war. President Truman himself, having a great interest in the services, will perhaps take a hand.

But whatever comes of it, the rule of reason ought to prevail. Our magnificent automobile industry would not be the stronger for combining the "big three." There is a middle ground in all such matters. We will be stupid indeed if we cast aside the history, traditions, and performance of the fighting forces which, individually and collectively as at present constituted, are winning the greatest war the world has ever known.

General Harris Decorated.—Maj. Gen. Charles T. Harris, Jr., commanding officer, Aberdeen Proving Ground, Md., was awarded the Distinguished Service Medal for his preëminent Ordnance achievement in World War II. The award was in the form of an Oak Leaf Cluster since the general was the recipient of the DSM for his services in World War I. The medal was presented by Lieut. Gen. L. H. Campbell, Jr., Chief of Ordnance, at ceremonies in the Pentagon, Washington, D. C., July 21, 1945. A photograph of the general and the wording of the citation are published on page 252.

This award to General Harris is of unusual significance for it honors a man whose contribution to industrial preparedness in the United States during the past quarter century is unsurpassed. Not only did he fight for the War Department against overwhelming forces during the tragic days of 1934-1939, but he also directed the vast power of industry when our rearmament program was started two years before Pearl Harbor.

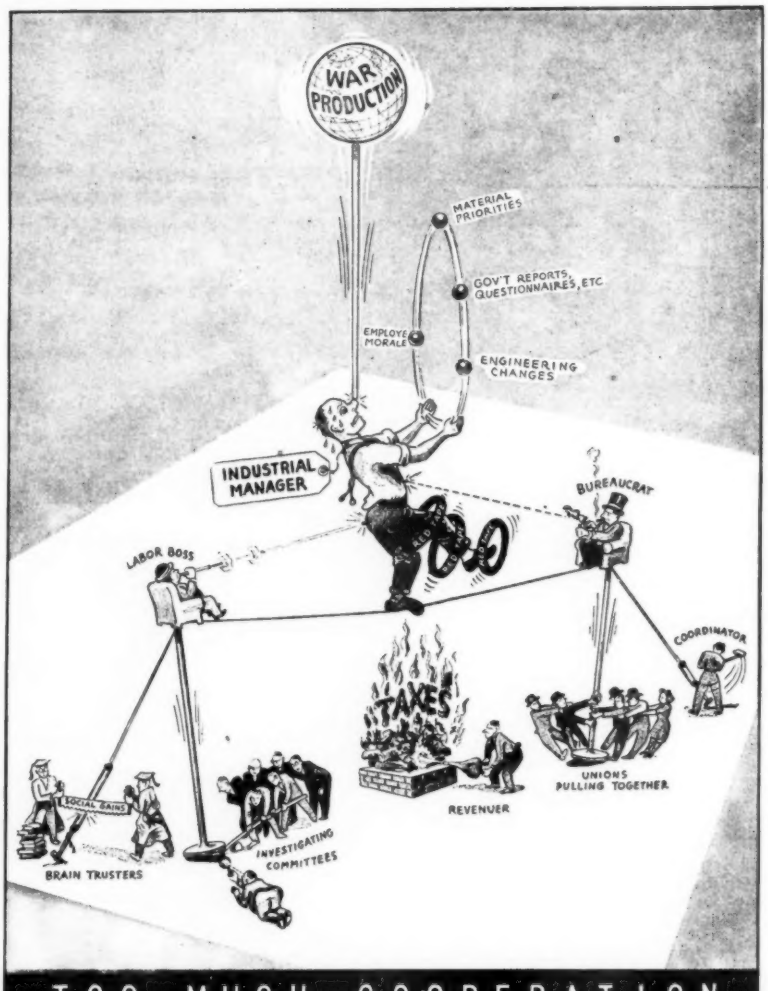
Having rendered conspicuous service in World War I he translated the lessons learned into the plans of the War Department during the two decades following that conflict. That the same officer should have the satisfaction of seeing all the principles for which he stood overwhelmingly acknowledged and put into practice in World War II is a contribution to our national defense worthy of highest acclaim. The Army Ordnance Association adds its word of praise to this stalwart officer and gentleman whose devotion to duty and correctness of thinking are a tribute to the Regular Army of the United States of which he has been a member for forty-two years.

Ordnance Marches On.—Ordnancemen in the great Southwest have established records within the past year which rival the rest of the country, especially those industrial sec-

tions long known for their Ordnance endeavor. Just as the march of industry has moved into areas once considered of secondary industrial importance, so today the Ordnance cohorts are in every State of the Union, especially the Northern, Middle Western, and Southwestern areas, and their numbers are on the increase.

Within the St. Louis Ordnance District there have been established within the past year six separate local Posts of the Association where formerly only one existed. The Ordnance forces, under the leadership of Col. Clyde H. Morgan, chief, and Col. Richard W. Coward, deputy chief, of the St. Louis Ordnance District, are doing great things. In a recent message to an organization meeting of the Lone Star Post, Colonel Morgan said in part:

"Technical skill and industrial efficiency will determine the victor in conflicts of the future. Industrial preparedness is of paramount importance for a nation to survive. This means that industry must be mobilized for peace in the same significance as it was drafted for war. Our manufacturers have constituted the front line of the industrial effort. This front must now be consolidated; it must strengthen and grow until it becomes our bulwark for national defense. The Army Ordnance Association provides the standard about which the legions of our industrialists may rally."



TOO MUCH COOPERATION

"During these times the industrial manager is in the position of a tightrope walker, juggling balls with his hands, twirling hoops with his feet, balancing a pole on his nose and with unsympathetic busybodies jiggling the guy wires."

Military Facts—The Bitter and the Sweet.—Our military personnel are given a very comprehensive education in almost every conceivable subject that can help them in the art of war. That is, in almost every conceivable subject except one—public reaction.

If there is one lesson our military and naval establishments should learn from the present war, it is that the old attitude of "the public be damned" can no longer be tolerated. Too many officers do not realize that they have an obligation to the public that must be fulfilled and that the suppression of legitimate news is one of their worst offenses.

Army censors are too prone to suppress bad news and allow correspondents to relay only rosy pictures. A prime example of this was the case last fall when the country was stunned by our reverses at the Bastogne Bulge. Our people had been ill-prepared for a reverse of any kind due to the flood of victories our Army had been piling up. Our Army leaders were prepared for counterattacks by the enemy and were ready for this one, but the public was not. Some of the commentators seemed to think we had lost the war; some of our military analysts said that our weapons were poor and inefficient. Yet in a few weeks these same "Grade B" weapons had managed to turn the German Army's retreat into a rout.

During this war the armed forces have found that by far the majority of reporters, writers, and correspondents are able to keep a secret. They are willing to wait until information about invasions, troop movements, and new weapons has no more military value to the enemy. But most Army officers run to cover when confronted by a reporter for fear that some remark of theirs will be distorted when printed and that they will violate some security regulation. The fact is that most of them do not tell enough. They leave a lot of it to the reporter's imagination. They should tell the whole story and tell him the parts he cannot print due to security. When the whole story with some of the background is known, an honest report can be made without jeopardizing security.

Deep sacrifices have been made at home by the men and women of this country, and they have the right to know that their lives and fortunes are being adequately safeguarded.

Only the truth should be told—the bitter with the sweet. Nothing can breed a sense of distrust more quickly than a steady diet of breastbeating and flagwaving. The public is adult in its thinking. It can be told that everything we do is not the best or that a cunning enemy is not exactly moronic. Candor when the going is rough is the best road to sympathetic understanding. The public does not expect the Army to put on a 3-ring circus, but it does expect to be kept informed within the limits of security. But don't let security provide a convenient excuse for a news blackout.

The War against Japan

An Editorial

THE LOGISTICS of the war against Japan involves distances so great and military effort so severe that our Army, Navy, and Air Forces are being put to the test as they have not been before. Reports of the concentrated naval bombardment of the Japanese homeland and accounts of the aërial bombings from carrier-based and land-based aircraft are indicative of the vastness of the fronts on which we are now fighting. The results thus far are a tribute to our Army, Navy, Marines, and men of the Air Forces for successful warfare over the most distant supply lines in our history.

¶ In the process of deployment the visits home of many of our high-ranking commanders have been good both for them and for us. The unusual high quality of the leadership which all our forces have had and now have in campaign and battle is brought sharply into focus. This leadership is of high order. The magnitude of the forces involved has been far beyond any former experience.

¶ The scientists, inventors, engineers, and manufacturers of America have produced weapons, instruments, and matériel most of which were undreamed of a decade ago. Our commanders are using these new tools as well as the old ones with great skill.

¶ All this points to the certain and, we hope, speedy and total defeat of our enemy in the Pacific. To this end all our energies are now directed. When victory finally comes, let us hope that our statesmen will display leadership on a par with that of our military, naval, and air commanders. Anything less will mean another shaky peace. The price we have paid to defeat Germany and are paying for the defeat of Japan is far too great in blood, substance, and money for us to relent one iota in winning the war and in staying strong to safeguard our own peace.

Britain's Bridgelaying Tanks

The Churchill bridgelayer lowers its 30-foot span across a gap with its huge pivot arm. The bridge, which will bear 38 tons, is then speedily detached and traffic continues as usual.

The Scissor is carried on a light Valentine tank from which it unfolds across a shell hole, antitank ditch, or similar obstacle. These tanks served against Germany, are now in Burma.

The Twaby Ark is mounted on a Churchill tank and is driven directly into the gap or stream to be crossed. The ramps are then lowered and following vehicles pass up and over it.

The Ark is also mounted on a Churchill tank and consists of 2 trackways running across the top. It is especially useful in enabling troops and other tanks to cross high obstacles.

Association Affairs

TWO NEW POSTS IN TEXAS

That the Industry-Ordnance team in the Middle West is really a working combination is shown by the fact that of the fourteen Posts of the Army Ordnance Association formed since Pearl Harbor seven are in the St. Louis Ordnance District.

Precedents were shattered on July 11th and 12th when two new Posts were inaugurated in Texas on two consecutive days giving that State three Posts to tie with the State of New York. The new chapters are the Lone Star and the Red River Posts. Both charters were presented by Col. Clyde H. Morgan, district chief, who had to do some tall hustling to get from Camp Hood (near Temple) to Texarkana in less than twenty-four hours.

Near Texarkana, and west of the Lone Star Ordnance Plant, is the Red River Ordnance Depot. Here the civilian employees and officers got together some weeks ago and petitioned for a charter for a local Post. A little later a movement was started by Maj. J. Kirby McDonough, president of the Murray Company of Dallas, to form a new Post for North Texas as experience has shown that Texas is too large for a single Post to function satisfactorily.

Distances are so great in the Lone Star State that the St. Louis Ordnance District maintains two regional offices there for procurement purposes—one at Houston and the other at Dallas. The original Texas Post, which was split from the St. Louis Post in 1942, now covers the same territory as the Houston Regional Office. The new Lone Star Post takes in the area of the Dallas Regional Office except for the eastern part which is covered by the Red River Post. The latter also takes in the northwest corner of Louisiana, including Shreveport, and southern Arkansas, including Little Rock.

The Red River Ordnance Depot, commanded by Col. R. N. Bodine, staged an afternoon show, "Prelude to Combat," in connection with the inauguration of the Red River Post. The visitors were treated to a fine demonstration of both vehicles and armament. Jeeps, armored cars, tanks, tank destroyers, and other automotive equipment were put through their paces. There was also firing of weapons from small arms to artillery pieces, and the afternoon was rounded off with a retreat parade and review honoring the members of the Army Ordnance Association.

In the evening, dinner was served in one of the post restaurants. At the dinner the Association's charter and flag were presented to R. S. F. DeMent, president of the new Post, by Colonel Morgan in a short speech sparkling with his inimitable brand of humor. After Mr. DeMent's acceptance, the meeting was moved to a nearby recreation hall where music and additional refreshments were available. The new Post is obviously composed of men who are interested and enthusiastic, and it promises to become an important part of the Industry-Ordnance team.

The Lone Star Post got off to what is believed to be a unique start. Major McDonough invited a small group to lunch on May 30th, at which affair twenty-eight life memberships were pledged. The inaugural meeting was held at Camp Hood on July 11th and an organization meeting on June 12th in Dallas. The Camp Hood meeting was arranged for by the Industrial Service of the Eighth Service Command, which had previously provided a somewhat similar outing for the Texas Post. Members who wished to attend signed cards certifying that they were either 4-F's or 3-B's (baldhead, bifocals, and bum back) and were ordered into the Army to be "soldiers for a day."

Regular induction orders were used with a fictitious draft-board number and were signed by Dewey D. Day, president of the Post, or by Charles Barry, secretary. One of these orders reached a son instead of the father, and its appearance was so genuine that the young man was completely taken in by it and wrote a most courteous and respectful letter explaining that he was already a first lieutenant in the Medical Corps Reserve and he felt sure that there was some mix-up. Considerable fun was had by many elderly gentlemen who went around displaying their "induction orders." No doubt any Japanese spies lurking in North Texas have by now sent word home that the United States is at last going in for an all-out war. Who knows but that the Lone Star Post may yet be credited with shortening the war!

The "inductees" left Dallas Tuesday morning in big Army buses and stopped for lunch at Blue Bonnet Ordnance Plant where they were the guests of Lieut. Col. Charles W. Walker, commanding officer, and L. R. Sanderson, of National Gypsum Company, general manager. Arriving at Camp Hood around 7 P.M., they were fed and issued bedding and uniforms after being roundly reprimanded by Lieutenant Koons, their company commander, for being late! They were then taken seventeen miles to a 57-mm. range for night firing. About midnight the trek back to camp and to bunks was started.

THE men were up for reveille at 5:45 A.M. and took the usual GI calisthenics, although it cannot be claimed that they were performed in exactly the usual GI manner. They had to make up their beds, police their quarters, and do all the regular GI chores. They ate a regular GI breakfast. The whole program was skillfully planned to give an accurate idea of the life of a soldier. That morning they rode the tank destroyers across country, over ditches, and up and down unbelievable slopes, and were amazed at the ease with which these blitz buggies went about their business.

They fired the carbine and the caliber .50 machine gun. They ate K rations in the field at noon and were startled that so much could come out of such a little box. In the afternoon the businessmen stood in the center of the line of attack while the Infantry moved by them to make the assault, and the 105's and machine-gun bullets passed over their heads to strike the "enemy" 1,000 feet away.

They learned the meaning of village fighting by going right through it with the other GI's, and then, after a long hard day in the field, the now-seasoned soldiers stood in their GI uniforms in parade formation while "Pvt." Dewey Day marched "front and center" to stand before Colonel Morgan and receive the charter of the Lone Star Post. When the charter had been handed to Mr. Day, the sunset gun was fired, and the men were brought to the salute as the Camp Hood band played the National Anthem.

That evening, after changing back into civvies, they were given a "battlefield promotion" by being allowed to eat in the Officers' Club. Here consternation was created by a message from the service command directing that they be held in camp until the matter of clearing them under the point system could be clarified. Colonel Morgan immediately sprang to the defense of the industrialists by stating that they were not actually in the Army since their papers were not issued from a bona fide board.

To this, Col. B. F. Delamater, commanding officer of Camp Hood, replied that the Army was not interested in the legality of their induction. This, he said, was a matter that would come under the jurisdiction of the civil courts. He stated that of course any of those present could obtain a writ of habeas corpus and perhaps get the court to direct their release, but he felt that this would take quite a long time and that the Army could work faster than that.

Some one suggested letting them go home on 3-day passes until the red tape could be cleared up, but it was pointed out that they would first have to be reprocessed and outfitted as privates. Then the objection was raised that it was not possible to furnish Government transportation to men on passes. It was also brought up that no such passes could be given anyway as all men at Camp Hood are required to take seventeen weeks' training!

Here Colonel Delamater rose to the occasion and said that he would take a chance on giving out the passes. He felt that the men could get home some way and added that any man in uniform would have no trouble hitchhiking two or three hundred miles. Just as all were trying to resign themseves to a long and arduous military life, another message came through ordering them released and stating that no 4-F's or 3-B's were desired. So back into the buses they were loaded and started for Dallas about 10 P.M. At 3:20 A.M. they were back at the dispersal point and found that their one day as soldiers had taken exactly forty-two hours which, they reasoned, was just another example of how the Army can get things turned around backwards!—COL. RICHARD W. COWARD.

NORTHWEST POST

The Northwest Post, Army Ordnance Association, held one of the most remarkable meetings yet recorded when at St. Paul, Minn., on July 12th, it honored Lieut. Gen. Levin H. Campbell, Jr., Chief of Ordnance, as its guest speaker. Not only was the principal speaker given a rousing welcome but the toastmaster of the occasion, Brig. Gen. Harold E. Wood, Minnesota State Forces, rivaled the great names in our history by his genius as a presiding officer.

The meeting was under the general chairmanship of Walter G. Seeger, vice-president of the Post, under whose direction the Ordnance forces in St. Paul have established enviable records. More than 600 members and guests assembled in the Hotel St. Paul for the dinner and meeting.

General Campbell and officers of his staff combined their attendance at the meeting with an inspection of Ordnance facilities in the Twin Cities area, including plants of the International Harvester Company, Federal Cartridge Company, Minneapolis-Honeywell Regulator Company, and the Twin Cities Regional Office of the Chicago Ordnance District, of which Lieut. Col. A. V. Stallard is in charge.

Following are extracts from General Campbell's address:

"I don't have to tell you people that the war is not over. Many of you have production schedules that must be met as long as Japan resists. Almost all of you have brothers, sisters, husbands, or friends who are in the active fighting areas. Certainly we will never let up for a moment while a single American soldier needs firepower.

"However, when this war is finally won, we members of the great Industry-Ordnance team have still another job to do—to assure that the peace which has been won at such great sacrifice is maintained over the long years to come. Every right-thinking citizen applauds the efforts made to date to set up the World Security Council through which all nations can freely exchange their ideas and express their views.

"General Eisenhower is reported to have said, in effect, that the weak never coöperate, as they are never given the opportunity. Only the strong coöperate. History proves the correctness of his reported statements!

"As I see it, we of the Industry-Ordnance team, when the final shot is fired at Japan, must at once undertake to put this country, Ordnancewise, in a position where it will be highly inadvisable for any enemy to attack. This can be done, I believe, at a very modest expense over a great period of time. What will be preparedness in the future? There was a time when it meant storing up quantities of supplies—powder and shells, cannon, small arms, uniforms, transportation equipment, and even food. The general staffs of past decades knew that their enemies had roughly so many cannon and so many troops and prepared to meet them. They knew pretty well what types of cannon they would face, and what kinds of small-arms fire would have to be overcome. For them, preparedness was the amassing of stocks of war supplies to meet fairly well known conditions.

"It is not so simple today. We have several problems. We must maintain a large stock of good weapons in constant readiness for a possible enemy attack. At the same time, we must be pushing our weapons-development program forward and must be keeping industry ready and able to shift to war production if necessary.

"With regard to keeping stocks of weapons readily available for emergencies, let us assume that no nation in the world is going to carry on a continuous large-scale rearmament program. Most certainly we all hope that our country will never do so. How better, then, can we protect ourselves over this long period of peace to come than by having in readiness for any eventuality a reserve of Ordnance equipment left over from this war?

"We are working now with the help of several firms in industry, and our own Ordnance talent, to evolve a method of storage of various types of Ordnance equipment which will preserve this matériel under ordinary storage conditions with little or no expense. We have reason to believe that we will be successful in our efforts to evolve such a system for storage, and if, unfortunately, we should ever be attacked, we will thus have immediately available weapons which have successfully conquered our three enemies of the present war. If our potential enemies have not rearmed on a large-scale basis in the meantime they will have no better weapons than we. So any war will start with our having an equal chance of winning in so far as weapons' equipment is concerned.

"In addition to storing weapons, we must keep active in the development of new armament. It will be wisdom, and will not cost much money, to store many of the fine weapons we will have on hand after this war; but we should not forget that the development of the arms of war is a dynamic science and cannot be frozen at any one point. We must keep the scientists and engineers of the Nation hard on the job delving into all fields of weapons' research. They must devise equipment that will meet the tests of climate and weather throughout the world. They must be able to counter any weapon that other nations may be developing.

"This research and development program should be guided by the Ordnance Department and should make full use of the great scientists and scientific institutions throughout this broad land. I do not believe that any one should be permitted to build up great laboratories within the Government. Why, in view of all that has been accomplished by scientists in civilian life, should a duplication be made?

"The Ordnance Department, in addition to guiding development, must also help formulate the plans by which industry can get into production of the latest and best weapons on short notice. When war threatens, days are precious. It is not enough to vote money when a crisis is at hand; we must have sound plans which our factories can follow in switching to war production.

"All this means that we must have adequate plans for converting rapidly to war production. We must have industry ready and able to change over from peacetime to wartime items. Industry can only be ready to do this if we spend substantial sums on pilot orders during peace. In addition, we must have detailed blueprints for the conversion of complete production lines from peace to war production. This is a tremendous engineering and administrative task, and millions of dollars will be required to lay a

solid basis for such a switchover. However, it is an unavoidable cost of proper preparedness."

Other speakers on the program were Luther S. Oakes, president, Northwest Post; Col. John Slezak, chief, Chicago Ordnance District; and Col. L. A. Codd, executive vice-president, Army Ordnance Association. Invocation was by Chaplain Alfred P. Klausler. Musical selections were by the Fort Snelling band. Active in arrangements for the meeting were the officers of the Post already mentioned and Harry A. Bullis, vice-president; Roland F. Wilson, secretary-treasurer, and the following directors: W. C. MacFarlane, Charles L. Horn, W. F. Kasper, Richard P. Carlton, C. E. Buckbee, Alfred M. Wilson, Brison Wood, Alex D. Chisholm, Harold W. Sweatt, Frank B. Winston, and Colonel Stallard. This meeting was excellent proof that the Industry-Ordnance team in the Northwest area will continue the important work of Ordnance preparedness after peace is won.

PUGET SOUND POST

Members of the Puget Sound Post were the guests of Rear Adm. R. W. Christy for an extended tour of facilities and ships at the Bremerton (Wash.) Navy Yard on June 26, 1945. The program was under the direction of Robert Nelson, chairman of the Post's program committee. Following the tour, members were extended the courtesy of the City Club of Bremerton where a dinner and meeting were held. Arriving at the navy yard at 2 P.M., members were personally conducted by officer personnel who explained the facilities of the vast establishment. At 5 P.M., refreshments were served at the City Club with the compliments of the Puget Sound Post. A short meeting was held following dinner.

ABERDEEN PROVING GROUND POST

The June meeting of the Aberdeen Proving Ground Post was in the nature of a general business session and discussion of plans and policies. It was held at the proving ground under the chairmanship of the president, Col. George G. Eddy. The meeting was called to apprize the membership of the activities, objectives, and future plans of the Association, to vote upon a proposed amendment to the bylaws, and to discuss the affairs of the Post with a view to soliciting the wishes and recommendations of the membership as to future plans and activities.

A full attendance of officers and directors of the Post and of a large portion of the membership resulted. The following officers and directors were in attendance in addition to Colonel Eddy: Col. Charles K. Allen, Col. O. R. Schurig, Col. E. S. Palmer, Maj. C. J. Koenig, Maj. J. A. Westbrook, Maj. Kieran J. Hackett, and R. H. Kent. In addition, Col. L. A. Codd, executive vice-president of the national Association, participated in the deliberations. The following standing committees of the Post were announced:

Meetings and Programs Committee: Dr. Edwin P. Hubble, chairman; Lieut. Col. Charles T. Claggett; Majs. Kieran J. Hackett, Theron W. Jenkins, and Frank I. Davis; Capts. Thomas J. Wilson and James R. Chandler; Lieuts. Thomas J. Marshall, Homer E. Turner, Paul Phillips; and Mr. Oscar B. Brockmeyer.

Ordnance Research and Education Committee: Mr. Robert H. Kent, chairman; Lieut. Col. Thomas R. Hoag; Majs. John S. Lieb, Robert E. Anderson, and Leon E. Clark, Jr.; Capts. Arthur H. Hartmuller, Samuel G. Dunlap, W. J. Fries, and John D. Dale; Lieuts. Robert T. Reed, Charles F. Kolankiewicz, and John F. Pelton.

Membership Committee: Col. Charles K. Allen, chairman; Lieut. Col. Otto R. Schurig; Majs. Alexander R. Wills, and Clarence J. Murphy; Capts. Raymond L. Birkholz, Ward E. Brown, and Joseph Dana; Lieuts. Robert Baxter, Lawrence N. Park, W. H. Marquess, and Mr. Aaron Stephenson.

Nominating Committee: Col. Clarence C. Harvey, chairman; Lieut. Cols. Emmett M. Stevens and Arthur W. Jordan; Maj. R. J. Russo; Capts. Samuel G. Dunlap, Charles H. Rothauge, D. B. Betts, Philip J. Fruitstone, Archie A. Langley, Joseph K. Dana, and Jeremiah G. Smithwick; Lieut. Lawrence N. Park; and Mr. Samuel H. Woods.

BIRMINGHAM POST

The Birmingham Post of the Army Ordnance Association was organized in December 1930 under the guidance of Col. Theodore Swann, assisted by then Capt. (now Brig. Gen.) David N. Hauseman. Soon the membership reached one hundred and was maintained at approximately this figure for a decade. This group of capable and energetic men did much to awaken industry to the need of preparation for national defense in a possible emergency and imbued it with the desire to perform its patriotic duty toward acquiring the knowledge necessary for rapid conversion from peacetime operations to the manufacture of war matériel.

Since the early days of the war the major objective of the Birmingham Post has been that of developing and maintaining close contact between industry and the War Department in order that the vast amount of knowledge and experience acquired by the Industry-Ordnance team might be retained for any future needs.

In November 1943 the Post selected the following officers to direct its affairs:

George M. Morrow, president; Lieut. Col. Allen Rushton, vice-president; Lieut. Col. R. E. Parker, secretary; and Lieut. Col. Thomas M. Nesbitt, treasurer. These officers immediately adopted as major objectives an increase in membership, and a broader scope of activities within the Post.

The Membership Committee, with Colonel Rushton as chairman, inaugurated a district-wide campaign which resulted in an active membership of 314 military and 1,633 civilian members—a total of 1,947 members on April 1, 1945. This number is approximately 1¾ times the goal of 1,100 set by the national headquarters. The membership drive will continue until all industries in the area of the Birmingham Ordnance District are represented in the Association. The distribution indicated above is in line with the desire of the national headquarters that the majority of members should be civilians.

The Post is now working out a postwar program which will have for its purposes: (1) Maintaining the interest of the members in the problems of national defense; (2) Keeping the members abreast of Ordnance progress and developments; (3) Aiding Southern industry in obtaining its share in the manufacture of peacetime Ordnance matériel; and (4) Developing the possibilities of Southern industry in peacetime production.

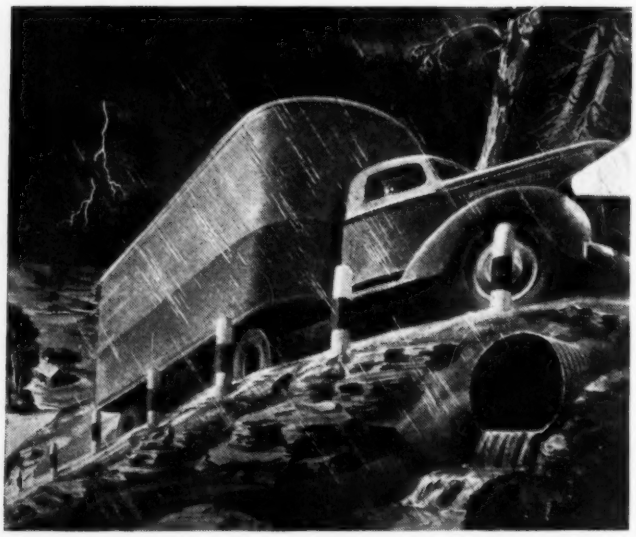
These officers are alert to industrial possibilities, and under their splendid leadership and direction the Birmingham Post will play an important rôle in the postwar economy of the South.

PHILADELPHIA ORDNANCE DISTRICT

C. Jared Ingersoll has relinquished his duties as chief of the Philadelphia Ordnance District after five years of service, first as deputy chief and later as chief. His contribution to Ordnance achievement in this war has been of outstanding merit. He is also president of the Philadelphia Post of the Army Ordnance Association and in both capacities has done untold good for the Ordnance cause. His service with the Department began as deputy chief to Brig. Gen. David N. Hauseman, who is now chief of the Readjustment Division, Army Service Forces. We quote the following from a tribute to Mr. Ingersoll which was published in the *Philadelphia Inquirer*, July 22, 1945:

"Ingersolls have been picturesquely familiar figures to Philadelphia since away back in 1787, when C. Jared's great-great-grandfather—also named Jared—signed the Constitution. The present head of the family line, now 51 years old, is one of the tallest men in the city, standing six feet six inches in his stocking feet.

"Associates on the boards of the Pennsylvania Railroad, Girard Trust, Western Savings Fund Association, Kansas, Oklahoma &



There must be no compromise with --Safety

Warner Vari-Load Electric Brakes are Safer!

TODAY, America is depending on motor transportation as never before. Every load of war materials and equipment carried by big trailer outfits must get through—and *on time!* Delays due to accidents caused by ineffective brakes must be prevented—there should be no compromise with *safety!*

It is significant that 80% of all power-brake equipped trailing vehicles purchased by the Government during this war—*have Warner Electric Brakes.* So take a tip from Uncle Sam—protect your drivers, your cargoes, and your trailer outfits—give them the EXTRA SAFETY of *Controlled Braking Power*—exclusive feature of Warner "Vari-Load" ELECTRIC Brakes. No matter what the weather, the driver can pre-set any and all brakes to fit BOTH load conditions and road conditions—thus keeping his train straightened out and under full control even when the going is slippery, and avoiding costly tie-ups due to damaged equipment.

On all future trailer purchases, specify Warner "Vari-Load" *Electric* Brakes—world-famous for safety, simplicity, and dependable, efficient, trouble-free performance.

WARNER ELECTRIC BRAKE MFG. COMPANY
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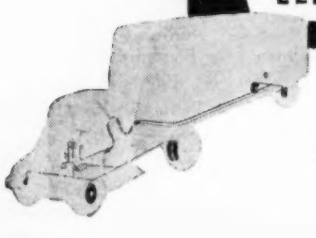
WARNER
ELECTRIC BRAKES



Only a few flexible wires. Nothing to freeze or chatter—no complicated mechanisms.

Association Affairs

Gulf Railroad, the Midland Valley, and a number of coal-mining companies, to say nothing of hospitals and civic groups, say he is also one of the hardest workers they ever have known. He has been first to arrive at the Ordnance office and the last to leave for the last five years.

"In World War I, Mr. Ingersoll enlisted and served as a lieutenant aboard a destroyer. His brother Harry was killed in action in France. In May 1944, Mr. Ingersoll got a telegram from the War Department notifying him that his only son, Jared, Jr., had been killed in Italy.

"That caused the former Princeton oarsman to pitch in and work just so much harder. At the time his son first tried to enlist he was not yet 18. 'He just wants to help win the war,' said Mr. Ingersoll. So the father redoubled his own efforts to that end and until he was physically unable to continue any longer.

"Lieut. Gen. Levin H. Campbell, Jr., Chief of Ordnance, accepted Mr. Ingersoll's resignation. In so doing he wrote a 2-page letter of commendation for the service the Philadelphian had given his country and his regret that Mr. Ingersoll would have to step out.

"Although Jared Ingersoll had not been much in the public eye as a speaker, his friends say he literally talked himself into his dollar-a-year job. He did that by buttonholing everybody he could find, following the fall of France, to ask them to join him in trying to get this Nation to enter the war.

" 'I wish war would be declared,' he said in June of 1941, 'so that we would all wake up to what the facts are on the present international situation. We ought to be building up our Army and equipment. We ought to get into the war in a big way.'

"The 'big way' started when Mr. Ingersoll was called in by the Army to organize industrial concerns for war production. Though he did not have the title of district chief at that time, he was the real director of some 600 prime Ordnance contractors and several thousand subcontractors in the area from Williamsport, Pa., to Trenton, N. J., and south to the Georgia state line.

"In a short time the Philadelphia district was spending $3,000,000 every 24 hours. Mr. Ingersoll's staff included 3,000 civilian employees and 175 officers and enlisted men, operating from headquarters in the old Bankers' and Manufacturers' Club at Broad and Walnut streets . . .

" 'These jobs don't pay much,' he told them. 'They mean hard work, all day Saturdays, and all holidays. But what of that? We're out to win the war and nothing else matters. If we don't do it, nothing that we're doing will be worth a nickel.' "

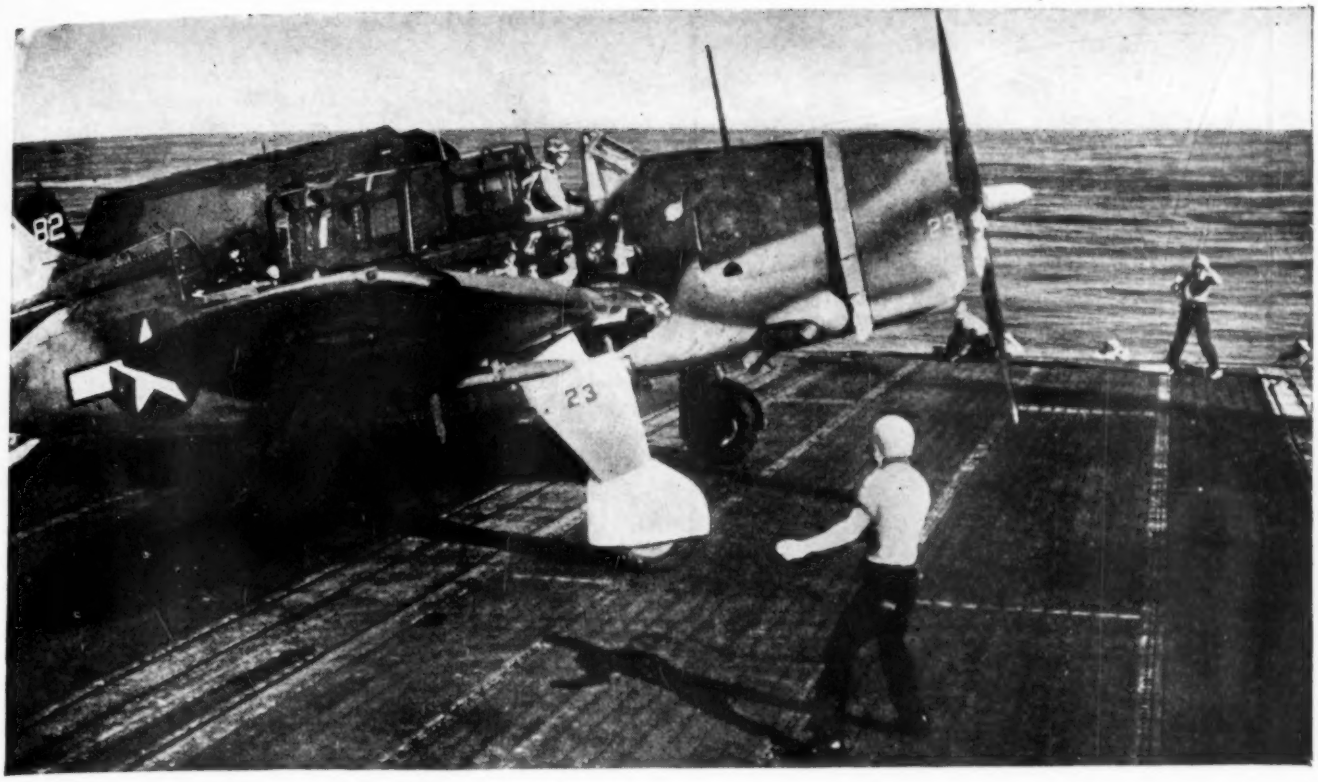
Mr. Ingersoll has been succeeded as district chief by Lieut. Col. A. D. Kelso, formerly deputy chief.

SPRINGFIELD ORDNANCE DISTRICT

John S. Begley has succeeded Brig. Gen. Guy H. Drewry as chief of the Springfield Ordnance District. General Drewry was recently called to Washington as chief of the Production Division, Army Service Forces. He had established an enviable record of performance in the Springfield District during the past 2½ years. General Drewry has served in the Ordnance Department throughout his military career and is especially expert in the design and manufacture of small-arms ammunition.

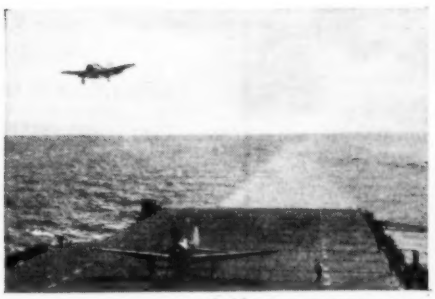
Mr. Begley has been associated with the Springfield District since March 1942 when he was named a civilian administrative assistant and chief of the legal division, later becoming deputy district chief.

A native of Holyoke, Mass., he was graduated from Holyoke High School in 1911, Phillips Exeter Academy in 1914, and Boston University Law School in 1919. During the first World War, he left law school at the end of his sophomore year, entered the Naval Aviation Service, and was commissioned an ensign. He was on active duty for fifteen months, largely at the Pensacola, Fla., naval base. Following the war he returned to law school and completed his course and has practiced in Holyoke since.

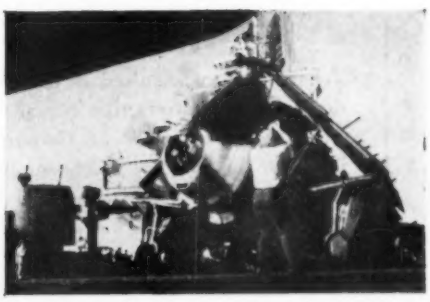


the "sunday punch"

This is the story of one of the deadliest weapons of the war—of one of the most versatile airplanes ever built, of the gallant men who fly it, and their magnificent combat record . . . But it is far more than one airplane, one day's headlines, one heroic step closer to victory.



Revenge was sweet at Rabaul, Japan's "little Pearl Harbor", where the Curtiss Helldivers first made combat history . . tearing through the Zeros to blast the Jap fleet. Score: 3 ships sunk—11 damaged. But that was only a good beginning.



Steadily spearheading our ground assault, the Curtiss SB2C Helldiver squadrons struck from the carrier fleet with smashing successes over the Marianas, at Saipan, the Second Battle of the Philippine Sea, over Okinawa and Tokyo itself.

BEHIND the battle record of the Helldiver is the story of thousands of men and women workers—one of the most skillful teams of builders ever known. It is the story of the courageous men of the air who fly and service our planes . . . an American story — with the pay-off in the promise of the future, when America's airpower is destined to serve a world at peace, in trade, in travel and in communication.

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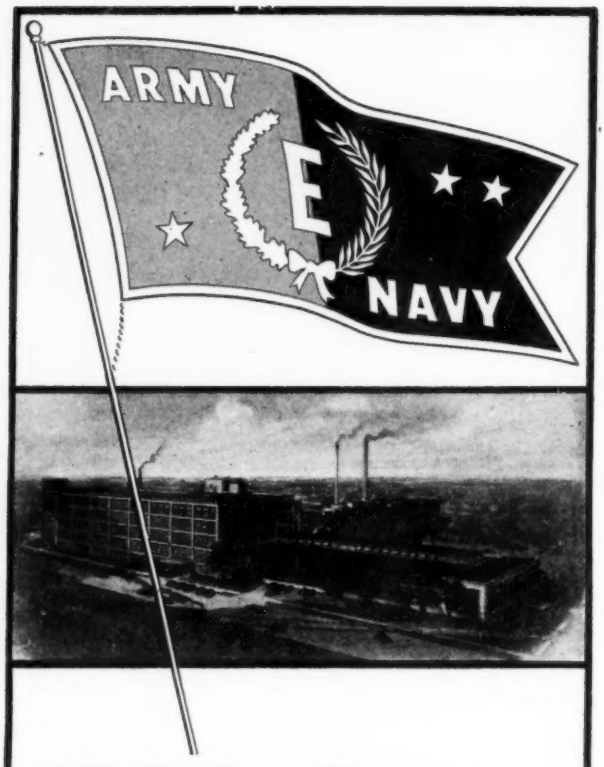

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The Preparation for the

Demands of War

Before the war, King-Seeley Corporation manufactured precision products in large volume for the automotive and allied industries—such items as gauges, speedometers, interval timers, governors and other comparable units.

The knowledge acquired in time of peace is now devoted to the production of war material for our Armed Forces. King-Seeley Corporation is, and has been, for the past two years, supplying a variety of ammunition components and other war items in ever increasing quantities; items of such nature and in such volume that present production schedules are possible only because of the skill and experience acquired in peace time.

That King-Seeley Corporation has succeeded in meeting and continuing to meet its war production demands in both quantity and quality is attested by the Army-Navy "E" pennant awarded in May, 1942, and which now carries three stars.

KING-SEELEY CORPORATION
ANN ARBOR MICHIGAN

Association Affairs

He has served as counsel for numerous corporations and has been active in civic and public affairs. He was a member of the Massachusetts Constitutional Convention in 1917, the Holyoke School Board from 1921 to 1927, and served as president of the Holyoke Community Chest in 1940 and 1941. He is a director of the Hadley Falls Trust Company of Holyoke.

COMMITTEE ON AIMS AND ORGANIZATION

The Committee on Aims and Organization, consisting of the presidents of all local Posts of the Association, is now at work on a draft report which, when completed, will be presented to the board of directors for approval. It is one of the most far-reaching advances of the Association during its twenty-six years' existence. It will be publicized in full to all members in due course.

The draft report now under consideration is the work of a subcommittee appointed by Col. Herbert A. Gidney, president of the Pittsburgh Post, chairman of the general committee. The subcommittee also consists of Edward T. Gushée, president, Michigan Post; R. E. Gillmor, president, New York Post; Col. James L. Walsh, a director, and Col. L. A. Codd, secretary, of the national Association. In transmitting the draft report to members of the general committee, Colonel Gidney said:

"There are many indications that the Army Ordnance Association must raise its sights! One of the most significant of these is the growth of our membership to nearly 50,000. The board of directors of the Association at their last annual meeting appointed a national Committee on Aims and Organization to consist of the presidents of all local chapters, with myself, president of the Pittsburgh Post, as chairman.

"To simplify the procedure of the committee and to present to it a suggested course of action, a subcommittee has been at work diligently on the problem for the past three months. We have evolved a tentative draft of the report to the national board of directors, copies of which are submitted to all members of the general committee for consideration, revision, and approval.

"It is our responsibility to chart the course of the Army Ordnance Association for another quarter-century. It is a most important undertaking considering the magnificent record of the Association. Let us all give the matter our best consideration and feel free to make any suggestions. Once this step is taken, we want it to represent the best thought of the entire membership."

ORDNANCE SCHOOL GRADUATE HONORED

At graduation exercises of the eighty-second class of officer candidates at the Ordnance School, Aberdeen Proving Ground, Md., on June 30, 1945, the Army Ordnance Association award—an honorary membership for one year—was presented to 2nd Lieut. Marion L. Smith. In making the presentation, Col. M. E. Wilson, commandant of the school, said:

"On behalf of the board of directors of the Army Ordnance Association I present to you this membership in the Army Ordnance Association. This award is made to you as the outstanding officer candidate of the eighty-second class of the Officer Candidate School. May your service as an officer in the Army of the United States be as outstanding as has been your work here as an officer candidate."

ORDNANCEMEN'S PROFESSIONAL SERVICE

Plans are now nearly completed for the establishment of an Ordnancemen's professional service. Its one and only purpose will be to help our Ordnance soldiers—commissioned and enlisted men and women—obtain their rightful places in civilian life. Here are the objectives of the new service:

1. It will be an agency to provide liaison between Ordnancemen and prospective employers by direct contact with industrial personnel departments; by making available to industry lists of qualified Ordnancemen available for postwar jobs; and by contacting unions on behalf of Ordnancemen in reference to job opportunities in selected areas.

10-Ton Navy Aircraft salvage truck

7½-Ton AAF truck-tractor for refueling planes

2½-Ton truck made for overseas

REO MILITARY TRUCKS

measure up to most exacting requirements —add new lustre to Reo name

Reo military trucks range from 1½-ton units to giant ten-tonners. The 10-ton job is equipped with a 26-foot boom crane and is used at airports to salvage wrecked planes. Two types of 7½-ton tractors have been supplied to the AAF—one hauls plane refueling tank trailers, the other is equipped with fire-fighting equipment. The 10-wheel 2½-ton model was built for overseas. The 1½, 3 and 5 tonners are standard Reo models with minor modifications.

Since 1904 Reo has built vehicles that have won a reputation for dependability and economy. The precision-built Reos in the service of the Armed Forces are adding new lustre to the Reo name.

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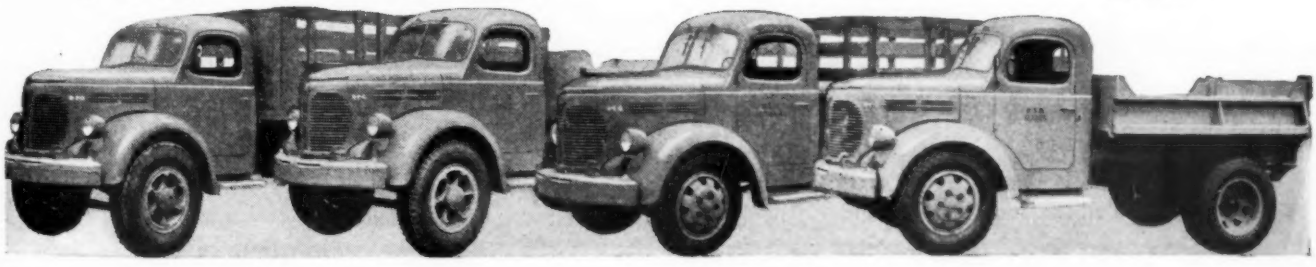
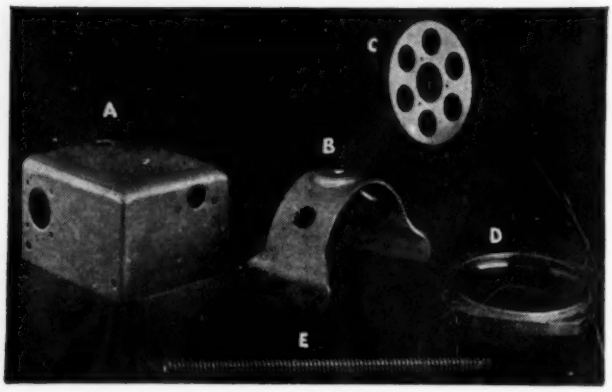
3-Ton Navy dump truck for general utility

1½-Ton Navy stake truck

1½-Ton Navy dump truck



Typical LEA *Finished Parts*



a—Yoke for Electrical Gyro
b—Bezel for Turn and Bank Indicator
c—Control Block for Actuating Units
d—Averaging Gear for Averagizing Unit
e—Jack Screw for Actuators

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Association Affairs

2. It will also constitute a vocational advisory service to Ordnancemen by providing nationwide job-opportunity pictures, by publishing current bulletins listing nationwide openings for Ordnance-trained personnel, and by listing educational opportunities for Ordnancemen seeking to improve their skills. It will point out small-business opportunities by publishing booklets containing professional advice on the establishment of such businesses and by advancing suggestions for the utilization of Ordnance experience in small enterprises.

The one big purpose of the new service is to bring humane relationships into this matter of getting jobs. Its work will be performed without fanfare—and without cost.

HONOR STUDENTS BECOME MEMBERS

The Illinois Institute of Technology, Chicago, Ill., conferred membership in the Army Ordnance Association upon ten of its honor students at graduation exercises June 25, 1945. The memberships were provided by the Chicago Post. In making the presentations, Dr. Henry Townley Heald, president of the Institute, said:

"The Army Ordnance Association, a national society of public-spirited American citizens among whom are executives, scientists, and engineers of American industry as well as military personnel, was organized in 1919, and there are now over 45,000 members in 32 different chapters throughout the United States. The Association's basic objective is industrial preparedness as our Nation's best guaranty of peace . . .

"The guaranty of national security in industrial preparedness is important because we are now going through a period of unparalleled engineering development and intense inventive effort. The aims of the Association are principally to translate its membership into an articulate group which will, through an interchange of ideas and knowledge, keep abreast of all developments and research in the Ordnance field and thus constitute itself a reserve of professional talent always ready for any emergency.

"In order that the competent and promising young engineers and scientists may participate in the good work of the Association, the Chicago Post is awarding 3-year memberships in the Association to the following honor members of the graduating class of the Illinois Institute of Technology: Angelo H. Caliendo, Donald C. Haack, Aloysius R. Kasmar, Herman W. Nelson, John J. Noble, Thomas F. Ruck, Robert Kovnat, John N. Mitchell, Norman S. Schmitz, and Robert C. Sweiger."

NECROLOGY

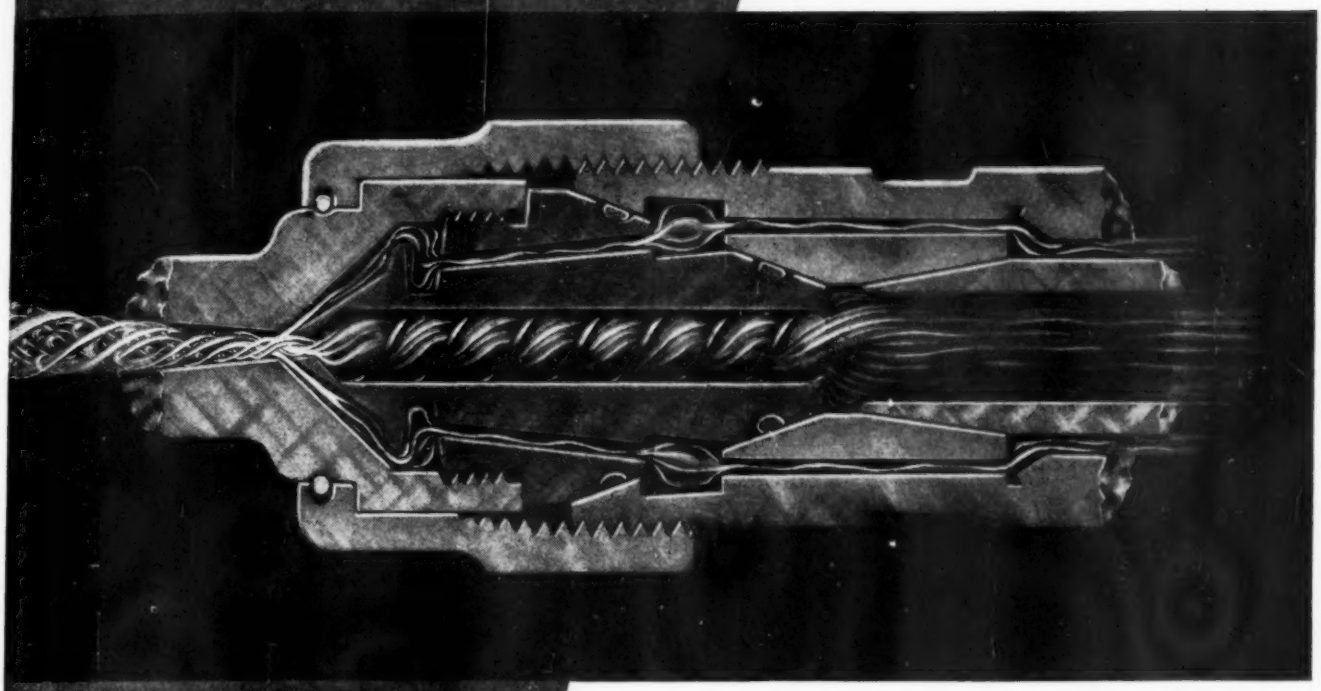
Thornton Lewis, lately on the staff of Brig. Gen. Hermon F. Safford, chief of the Ordnance Production Service Division, died at his home in New Hope, Pa., July 4, 1945. He had recently retired from the Ordnance Department, having rendered outstanding service in connection with the production program.

A native of Kentucky, Mr. Lewis formerly was executive vice-president of the Carrier Corporation, Syracuse, N. Y. First in the Philadelphia Ordnance District at the start of the war, and later in the Office of the Chief of Ordnance, he brought to both organizations a broad experience and acquaintance with industry which was of special value in the utilization of substitute materials in the days when shortages were critical. An intensely active and energetic person, he possessed a personality of unusual charm which endeared him to all those who were privileged to serve with him.

Herbert Tutwiler, life-long resident of Birmingham, Ala., civic and industrial leader in that area, and until July 1st chief of the Birmingham Ordnance District, died suddenly at Ponte Vedra, Fla., July 15, 1945.

From February 1942 until July 1, 1945, only fifteen days before his death, Mr. Tutwiler served the Ordnance Department. He was persuaded to enter duty as special civilian assistant to the

NO...This is not a robot bomb!



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district chief by Col. J. D. McIntyre, then deputy district chief. On August 1, 1942, Mr. Tutwiler was appointed deputy district chief to serve with Col. E. C. Bomar, district chief.

When Colonel Bomar was transferred to Washington, Mr. Tutwiler assumed the duties of district chief effective June 21, 1943—one of three civilians in the country to hold such a position. During the period he served as chief, the value of Ordnance production per month for the district increased some 2½ times, and at one time the value of contracts on the books reached a peak of approximately $290,000,000. Mr. Tutwiler submitted his resignation at the insistence of his physician.

His business connections included the following: president, Tutwiler Hotel Company; president and director, North Birmingham Land Company; president and director, Leeds Improvement Company; vice-president, Tutwiler Investment Company; president, Black Creek Coal & Coke Company. He was also director of the following: First National Bank, Woodward Iron Company, Vulcan Rivet & Bolt Corporation, Birmingham Fire Insurance Company, Realty Mortgage Company, Elmwood Corporation, Alabama Mining Institute, Twentieth Street Realty Company—all of Birmingham.

The esteem in which Mr. Tutwiler was held can be grasped from an article published before his death by the Birmingham *News-Age Herald* from the pen of John Temple Graves, widely read columnist:

"A war job that ends Saturday is as close to the heart of this city as it is to the record of our war plants. It is Herbert Tutwiler's job as chief of the Birmingham Ordnance District. One of only three civilians to hold such a post, presiding now over $200,000,000 of outstanding contracts, sticking to it through sickness and in health, carrying his share of war's emotional burden with one son lost, and another greatly in danger, managing through all to live his fine life as citizen, churchman, and family head, Herbert Tutwiler is entitled to be called Alabama's greatest soldier out of uniform."

ARMY ORDNANCE adds its expressions of sorrow upon the loss of a great patriotic leader. His service to his community and his country in many fields is best exemplified by his contribution to Ordnance for victory in this war. We mourn the passing of a friend, counselor, and patriot who was also the father of the late Lieut. (j.g.) Herbert Tutwiler, Jr., killed in action, and Lieut. Temple W. Tutwiler, II, returned prisoner of the German Government.

Mr. Tutwiler has been succeeded as chief of the Birmingham District by Col. J. E. Getzen who previously served as deputy chief.

NOTICE also has been received of the deaths of the following members of the Association: A. J. Bessolo, Pittsburgh, Pa.; Anton Brotz, Kohler, Wis.; T. P. Callahan, Woburn, Mass.; A. E. Cutler, Attleboro, Mass.; M. J. Czarniecki, Pittsburgh, Pa.; J. G. Dolby, New York, N. Y.; F. A. Frey, Milwaukee, Wis.; H. J. Goss, Waterbury, Conn.; Charles Hardy, New York, N. Y.; J. H. Hirsch, Chicago, Ill.; L. F. Johnson, Glen Ellyn, Ill.; E. E. Jonas, Cincinnati, Ohio; F. E. Knaack, Dayton, Ohio; E. C. Landram, Gallup, N. Mex.; F. F. McIntosh, Sewickley, Pa.; W. J. Magavern, Buffalo, N. Y.; R. E. Mann, Benicia, Calif.; H. W. Mason, Brattleboro, Vt.; A. H. Moore, Washington, D. C.; A. C. Penman, New York, N. Y.; G. A. Saper, Houston, Tex.; T. J. Savage, Shreveport, La.; George Scholl, Cincinnati, Ohio; F. W. Schumann, Cincinnati, Ohio; T. M. Skove, Cleveland, Ohio; F. Sparre, Wilmington, Del.; E. C. Swain, Waltham, Mass.; H. G. Trimble, Port Arthur, Tex.; Donald Vickers, San Diego, Calif.; D. J. Walsh, Jersey City, N. J.; W. F. Wiese, Omaha, Nebr. To their relatives and friends, ARMY ORDNANCE, on behalf of the Association membership, extends condolences.

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TRENCH MORTAR BOMBS ☆ ARMOR PIERCING SHELLS ☆ ORDNANCE AMMUNITION STEEL CASTINGS ☆ COMPLETE TRACKS FOR TANKS AND COMBAT VEHICLES AND HYDRAULIC AND MECHANICAL JACKS .....

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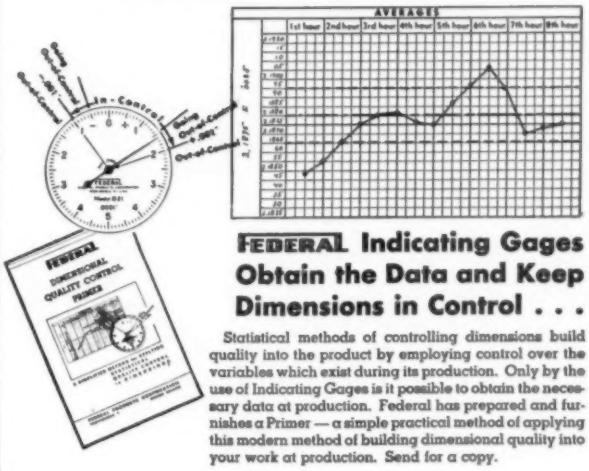

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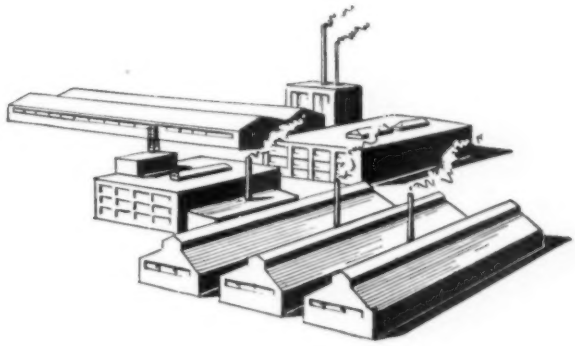

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BY LOUIS BRUCHISS

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Now, what makes a battle plane "tick" is its armament! And the just published AIRCRAFT ARMAMENT gives you for the first time the *complete story* of the world's air armament. Special chapters on: (1) Early History; (2) Aircraft Bombs; (3) Aircraft Machine Guns; (4) Aircraft Cannon; (5) Ammunition; (6) Turrets; (7) Foreign Aircraft Weapons; (8) Armor Protection; (9) Antiaircraft Weapons; (10) Gunnery Training; (11) Self-propelled Ammunition and Bombs; (12) Future Aircraft Weapons and Air Warfare.

AIRCRAFT ARMAMENT contains 224 large, 8½" x 11½" pages, with over 400 illustrations. The Foreword is by Brig. Gen. R. C. Coupland, Air Ordnance Officer for the USAAF.

Read what the authorities say:

ARMY ORDNANCE: *"The current importance of this work is undeniable . . . Presents all available material to give the Ordnance specialist, aircraft engineer, manufacturer, and the student of modern warfare an extremely valuable treatise on armament aloft."* (See page 456 of the May-June issue of ARMY ORDNANCE.)

AVIATION: *"The textbook quality of this volume marks it as a work of particular interest to armament men . . . A stimulating section on future aircraft weapons . . . a pertinent, definitive work."*

SCIENCE NEWS LETTER: *"The history and development of aerial fire-power is exciting reading."*

***See article by the internationally famous Louis Bruchiss on page 244 of this issue of* ARMY ORDNANCE.**

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PROFESSIONAL DIGEST

BOMB DISPOSAL WORK DISCLOSED

For the first time since its activities began immediately after Pearl Harbor, the Bomb Disposal Division of the Ordnance Section, European Theater of Operations, has been scratched from the top-secret list. It is now possible to reveal the exacting and dangerous duties of the bomb-disposal squads whose casualty rate jumped to six per cent when the U. S. armies invaded the Continent.

Bomb disposal, as distinguished from removal of booby traps and land mines, which is the mission of the Corps of Engineers, can be defined as a task requiring expert recognition and neutralization of all types of bombs, shells, and explosives.

Under the guidance of Col. Thomas J. Kane, chief of the Ordnance Bomb Disposal Division in the ETO, 135 officers and 1,000 enlisted men have carried on the work of "delousing" the land over which our armies have crossed the Continent. Colonel Kane, formerly yardmaster for the Baltimore & Ohio Railroad at Rochester, N. Y., entered the service in 1940 and began his researches in bomb disposal in 1941 during the blitz of London. He returned to the United States and set up a bomb-disposal and bomb-reconnaissance school at Aberdeen Proving Ground, Md.

More than 50,000 trained experts in bomb-reconnaissance work were sent out from Aberdeen. At that time there was extreme danger of the bombing of civilians in the United States. The school at Aberdeen turned out personnel with ability to teach civilian-defense workers the recognition of explosives. Four companies of bomb-disposal soldiers were sent from Aberdeen in four directions—to the East Coast, West Coast, Hawaii, and the Canal Zone. Courses for officers lasted seven weeks, while enlisted men got fifteen weeks of training. Bomb-reconnaissance work required only a week's training.

The bomb-disposal school, under Colonel Kane at Aberdeen, was set up after careful research. In 1942 Colonel Kane went to all theaters of operations for study and visited England, North Africa, Iran, India, Russia, and China in a 6-month tour.

Since the beginning of the invasion of the Continent, the research and development section of the Bomb Disposal Division, headed by Maj. John E. Feldman of Baltimore, Md., has refined methods of bomb deactivation to such an extent that a 40-pound kit contains all the instruments now necessary for a task which once required a 5-ton truckload of materials. Methods which are still not for publication have simplified the neutralization of dangerous explosives to such an extent that, as Colonel Kane said, "Anything we can dig down to and uncover without exploding we can carry away in safety."

Since D-day, when four squads of bomb-disposal officers and men went to work on the beaches of Normandy clearing away unexploded artillery shells, rockets, German parachute mines, and long-range time bombs, BD Division personnel have removed on the average of 3½ tons of munitions and unexploded bombs a man each month. About 1,600 tons of bombs and explosives were removed from the Paris area alone shortly after the occupation.

The high rate of casualties among BD men is not due primarily to the exploding of bombs on which they work. Artillery fire, snipers, and machine guns account for most of the casualties. Often BD men, who are not listed as combat troops, go out into the battlefield ahead of the infantry to "delouse" the area.

A BD man must be able to recognize and deactivate between 200 and 300 types of German fuzes including many kinds of artil-

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lery fuzes. The first unexploded buzz bomb in England underwent careful examination by BD experts who say, without boasting, that they can safely handle any fuze they have come across thus far.

THE JONES DETONATOR LOADER

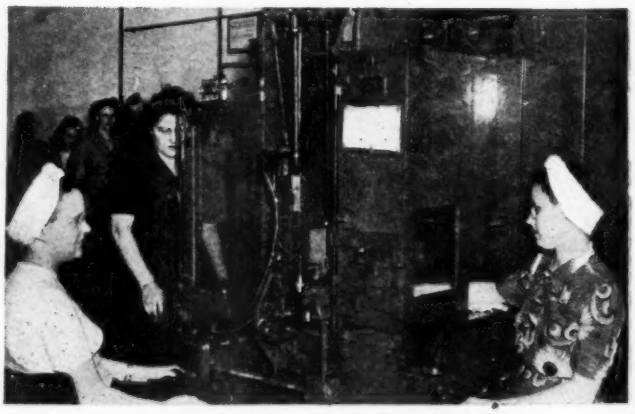
Early in 1943 urgent calls from the battle fronts revealed that allied estimates for heavy ammunition would have to be increased greatly; in fact, tremendous new production schedules made necessary by the stepped-up program called, and are still calling, for detonators in numbers which reached astronomical proportions. The three factors involved in meeting this unprecedented situation were: man power, materials, and manufacturing facilities. The highest hurdle in this case was found to be man power.

Some time before this critical situation developed, a machinery expert in Ohio, by the name of R. A. Jones, had volunteered his services to the Ordnance Department. He was given the task of making a machine that would facilitate the mass production of detonators. Previous experiments along this line by other companies had resulted in failure, and expectations were not too optimistic owing to the difficulties in safely handling by machine the extremely sensitive explosives used in this component. However, the Jones Company, in close liaison with Picatinny Arsenal, Dover, N. J., utilized the valuable lessons learned in the previous experiments and finally succeeded in perfecting a machine that "does everything but talk."

Because of the vital importance of the detonators and the enormous quantities involved, the placement of these "robots," few in number, was very carefully considered. The Arkansas Ordnance Plant at Jacksonville, Ark., had already proved that it could produce quality detonators efficiently and at low cost, so this plant received the coveted designation and, under cover of strict secrecy, installed the first of the Jones machines in September 1943. On the 13th of that month the first trial loading was run on Detonator No. 4.

AS A GAUGE of the efficiency of this complicated mechanism, 6 operators can make the necessary preparations and can load 13,000 detonators each 8-hour shift as against 15 operators hand loading 7,500 detonators in the same length of time. In other words, approximately four times as many detonators per operator can be loaded by machine as by hand.

Thus, a saving in man power can be estimated at twenty persons for one 8-hour shift for each machine. Translated into



The Jones detonator loading machine.

terms of man-hours for each 24-hour day of three shifts per 7-day week, each Jones machine will conserve 174,720 man-hours a year—a lifesaver for the whole war effort. To make this economy of time even more graphic, try to imagine a pile of 47,500,000 detonators. That stupendous number could be turned

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out by Jones machines in the annual man-hours saved by each machine. Quite a saving in floor space is also possible, as two machines may be operated in one bay, or loading room, thereby producing approximately four times the number of detonators from the same bay.

The accident rate per unit of production at AOP has been considerably reduced since the installation of the machines. Because many hand operations are eliminated, the exposure incidence can be said to be reduced about 400 per cent.

With raw materials assured as above, the "robot" takes over and processes a typical component through these subsequent steps: (1) A detonator cup slides down from the hopper to be released. (2) The cup is tripped into the correct position. (3) An arm slides the cup forward. (4) A punch forces the cup into a sleeve on the turntable. (5) At the next station, the cup is gaged. A short cup, an inverted cup, no cup, or a cup with a malformed top will automatically stop the machine. The cup is removed by hand and another is inserted. In the case of "no cup," a cup is inserted. (6) An aluminum-foil disk for the bottom of the cup is punched and seated in one process. (7) An operator scoops powder and pours it into the cup. The process inspector performs a ten per cent test of the scoop every hour. (8) The charge is consolidated by a press to a predetermined pressure. (9) One tetryl pellet is fed into the cup from the tube. (10) The tetryl charge is reconsolidated to a fixed height that will produce a definite over-all length after crimping. (11) The cup is closed with a disk of colored aluminum foil which is punched and deposited from a roll. (12) The cup is crimped at a 45-degree angle, excess powder removed by vacuum, and then flat-crimped. (13) The completed detonator is lifted from the sleeve by a mechanical finger and slides down a chute leading to a catch tray. (14) An operator removes the tray. (15) Another performs a one hundred per cent inspection and trays the detonators. (16) They are then given a moisture-proofing treatment by hand.

Some of the steps have been refined and improved upon by the technical tool men of AOP, and improvements in methods constantly go on. From operators on the line to the highly trained tools specialists come new, adaptable ideas.—EDWIN COX, *former editor of the Arkansas Ordnance Plant News.*

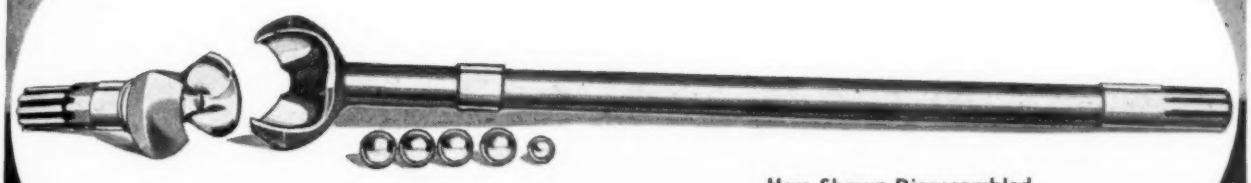
PACKAGING ORDNANCE MATÉRIEL

The time was early spring of 1942. The place was New Caledonia. The weather was everlastingly rainy, and the ground was soggy. The troops who worked to prepare for the initial assaults on Japan's South Pacific bases were among the first to leave the United States for that faraway theater. Some had sailed a week after Pearl Harbor. They worked with a feverish energy, and they ate ravenously. But not even the mess sergeant, until he opened his cans, knew what they would eat for the next meal. The principal food store was a mountain of unlabeled, unboxed tin cans not far from the water's edge.

When this division left the States, it had plenty of supplies. The men had stopped in Australia, reloaded their ship, and landed through the surf on the shores of New Caledonia. But their supply situation was serious and tragic. Most of their supplies were of standard commercial pack—cardboard cartons and paper labels on cans. Wooden boxes and crates at that time were built to save lumber and weight. Delicate instruments were protected against ordinary shock and scratch, but not against fungus and moisture.

What happened when they put their supplies ashore? The cardboard cartons soaked up the rain and fell away. Paper labels washed off cans. Neat stacks of food stocks became shapeless piles of tin cans. When the cooks went to the outdoor pantry they didn't know whether they were getting beans or potatoes, soup or meat, vegetables or fruit juice! As the weeks passed, other classes of supplies suffered. Leather goods deteriorated

In The Bendix-Weiss Rolling Ball Universal Joint



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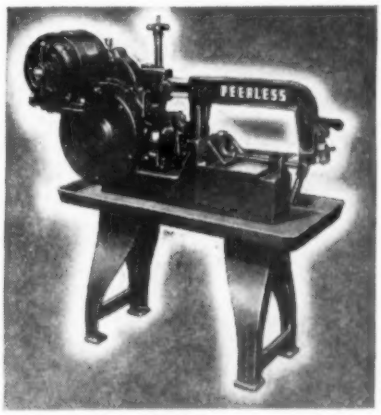

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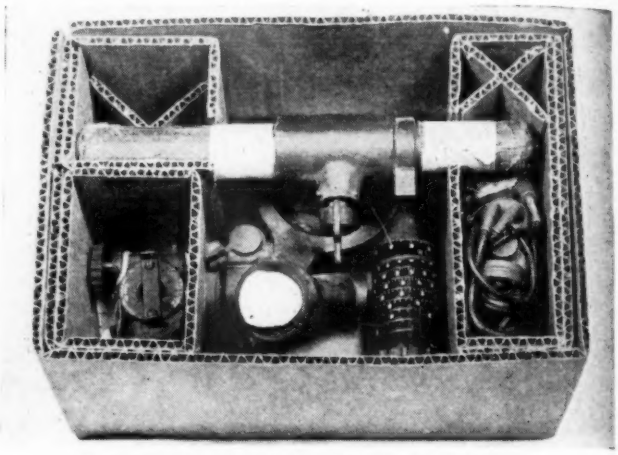
from heat, moisture, and fungus. Fine lenses developed "spider webs" from bacteriological attack on optical cements. Polished machined surfaces lost their luster and their usefulness.

Peacetime packaging specifications—the types of pack necessary for ordinary shipments—weren't designed for conditions met in wartime. A peacetime package moves from shipper to destination by rail or truck. If it goes overseas, it waits in a warehouse until a ship is ready, is then loaded with comparative leisure and care, unloaded the same way, and put back into a warehouse.

What happens in war? That package is stored outside awaiting loading on a ship. It is then packed deep in the hold with crushing weights on top. It may be lashed to the deck and left



First step in packaging a fire-control instrument.

exposed to the weather. At its destination, it is picked up in a big cargo net and dumped into a DUKW for a trip through the surf to an outdoor storage area. It may stay there for months. It may be quickly dumped as the GI handlers dodge shrapnel and sniper fire. On invasion beaches they don't have time to set up nice location systems and keep records of what is landed!

THE Army faced the facts. The packaging experts called from industry spoke frankly. One ever-practical specialist who joined the Ordnance Department told the awful truth when he said, "The mess we saw in the jungles of the South Pacific and on the shores of North Africa made us realize that as far as packaging was concerned we were 'caught with our pants down!'"

The Chief of Ordnance, Lieut. Gen. L. H. Campbell, Jr., laid down the law. He ordered the development of adequate packaging techniques and materials and their application all along the line. An extract from his orders says: "Mere shipment of the proper items of matériel does not constitute delivery unless the matériel is protected against all hazards it may encounter en route to the using troops."

Packages had to be designed to withstand crushing weights, months of exposure to heat and cold and rain, the penetrating and corrosive moisture of the sea, immersion in mud or water, the shock of rough handling by men and machines loading and unloading ships in half the normal time, and continuous movement and handling.

"Adequate packaging is just good insurance," says Maj. B. O. Montgomery, operations officer of Frankford Ordnance Depot, whose fire-control and antiaircraft items comprise one of the most difficult Ordnance packaging problems. "It may cost more to pack an item properly than it did to make the item in the first place, but regardless of cost we want to get that item to the man who needs it in a condition to be used. By applying

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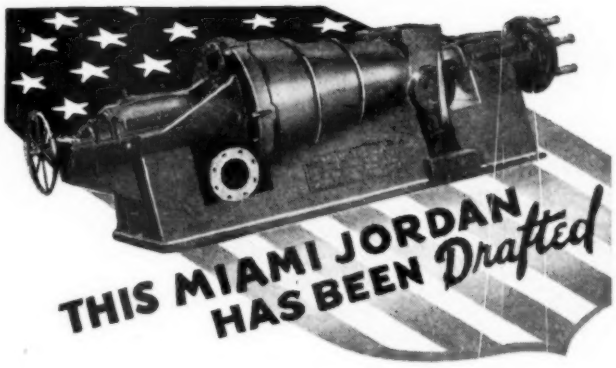

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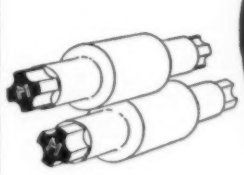

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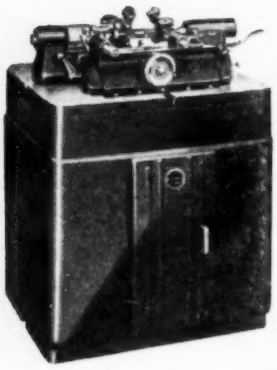

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The Red Ring Universal Gear Checker is built in three sizes, the 12" size for gears from ¼" to 12-11/16" O.D., the 18" size for gears from 2" to 18⅞" O.D., and the 24" size for gears from 3" to 24⅞" O.D.

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the proper pack, we try to insure against moisture or against the shock of being dropped onto a pier or the ground."

Frankford has to pack watch jewels—almost microscopic in size—and complicated precision optical measuring instruments—such as a 2-ton height finder. Enough nails, paint, paper, and lumber to build one hundred and fifty 5-room houses have been used at Frankford Ordnance Depot to insure delivery of fire-control and antiaircraft items. The steel banding on these boxes would stretch from New York to Chicago, and the wax would polish half a million automobiles.

Surprising techniques have been developed in the packaging line. After months of experimenting with waterproofing of all types, Ordnance took its cue from the canning industry and started putting binoculars up like baked beans. Fungus and moisture have been foiled by packing many optical instruments in hermetically sealed cans. The can opener now takes its place with the jimmy as an unpacking tool.

Sometimes a thin-filmed, artificially dried coating may be applied. Sometimes a plastic coating is sprayed on which hardens and may be peeled off later. In some cases another wrapper must be put on to protect the basic preservative. A dehydrating agent must be enclosed in the package to absorb the moisture trapped inside the box. And the cover may be a thin, transparent acetate or a heavy asphalt-impregnated multiply paper.—CAPT. E. R. TRAPNELL, *executive officer, Frankford Arsenal, Philadelphia, Pa.*

THE RISE OF REDSTONE ARSENAL

Redstone Arsenal is the only Government-owned, Government-operated arsenal of the Ordnance Department established during this war and is, therefore, referred to as a "permanent establishment" rather than "old-line arsenal." Redstone was activated October 6, 1941, and the first items of production came off the lines on March 28, 1942. Thus Redstone becomes the seventh of the manufacturing arsenals. Its production includes chemical shells, grenades, shell bursters, and demolition explosives. A résumé of the high points in the arsenal's working career will give some idea of its accomplishments:

In December 1942, the first Army-Navy Production Award was made. On March 7, 1943, its name was changed from Redstone Ordnance Plant to Redstone Arsenal. On June 18, 1943, Redstone received the War Bond Minute Man Flag—the first of 200 installations in the Fourth Service Command to earn the coveted banner. On July 17, 1943, a second "E" was awarded; January 15, 1944, the third "E" was awarded. The Ammunition renovation program began on June 11, 1944. On November 6, 1944, the fourth "E" was awarded, and on November 26th the $500,000 expansion program started. Redstone's all-time high in employment—4,522—was reached on December 20, 1944.

On January 16, 1945, a $3,000,000 expansion was announced, and in the same month Redstone led all other War or Navy Department installations in the Southeastern States in the utilization of physically handicapped persons, with a percentage of 18.1, and has consistently been among the first 5 leaders in its division in the current General Campbell Safety Contest.

The only one of the manufacturing arsenals located below the Mason-Dixon Line, Redstone is situated in Madison County, twelve miles south of Huntsville, Ala. The arsenal occupies 4,500 acres of rolling terrain immediately west of a range of the Cumberland Mountains on land which was formerly devoted to the raising of cotton, peanuts, and livestock.

The War Department chose these beautiful rolling acres on the bank of the Tennessee River for the site of the arsenal as a result of a number of important determining factors, some of which are as follows: It is inland and away from a vulnerable coast; is in the center of the world-famous TVA area and thereby amply supplied with electric power; the surrounding territory affords an adequate supply of labor; the climate

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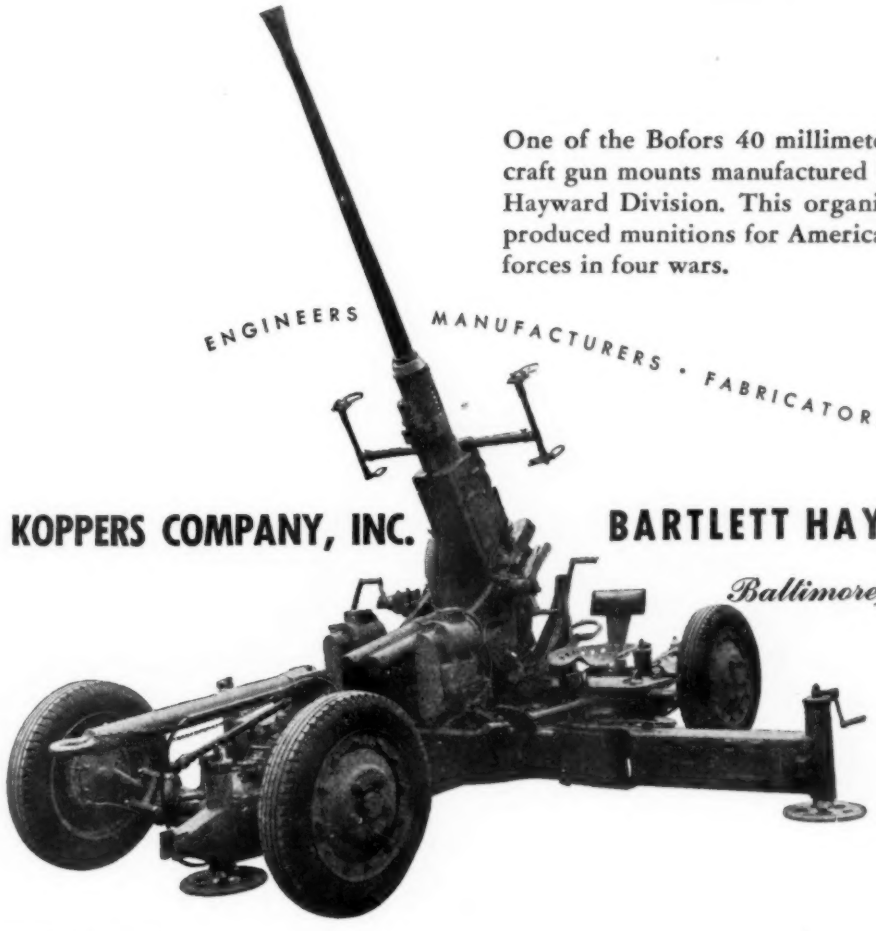

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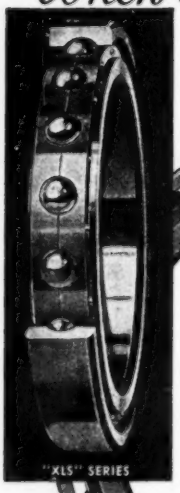

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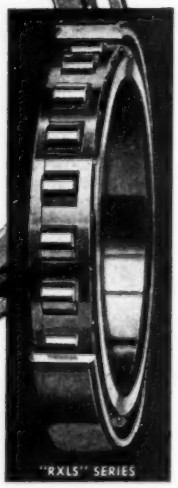

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Redstone Arsenal is now one of the best-equipped war plants of its size in the country as well as one of the most efficiently planned and constructed. Costing in excess of $18,000,000, it consists of over 240 buildings, grouped into administrative, manufacturing, storage, classification-yard, and proving-ground areas.

THE production lines in the manufacturing areas are designed to load and assemble high-explosive and chemical ammunition. The present activities of the arsenal include manufacturing and loading of high-explosive bursters for chemically filled artillery shells and bombs; manufacture of demolition blocks for combat engineers and paratroopers; loading and assembly of medium- and major-caliber artillery ammunition and rifle grenades. The technique of mass production of tetrytol, a binary mix, was perfected at this arsenal and is currently used in the loading of certain bursters, boosters, and demolition blocks.

Colored-smoke rifle grenades and artillery projectiles, up to and including the 155-mm., are a regular item of production at the arsenal. The colors cover a wide range, including white, red, green, yellow, and violet. These items are in continual use by the field troops for a wide variety of purposes.

An unusual use of an item of ammunition produced at Redstone Arsenal is for firing propaganda and information leaflets, medical supplies, and blood plasma to locations on the fighting fronts. The ammunition is of the base-ejection type and is prepared complete with fuze and ejection charge but without a filling. In the field, leaflets or medical supplies, as the case may be, are inserted. About 300 leaflets, 6 by 9 inches, can be inserted into the cavity of the 105-mm. shell. The fuzes are timed to go off when the shell is in the air over the desired location.

The renovation section, engaged in renovating ammunition returned from overseas, is gradually assuming a position of equality with any of the regular production lines. This is a result of the gradual return of increasing amounts of this ammunition.

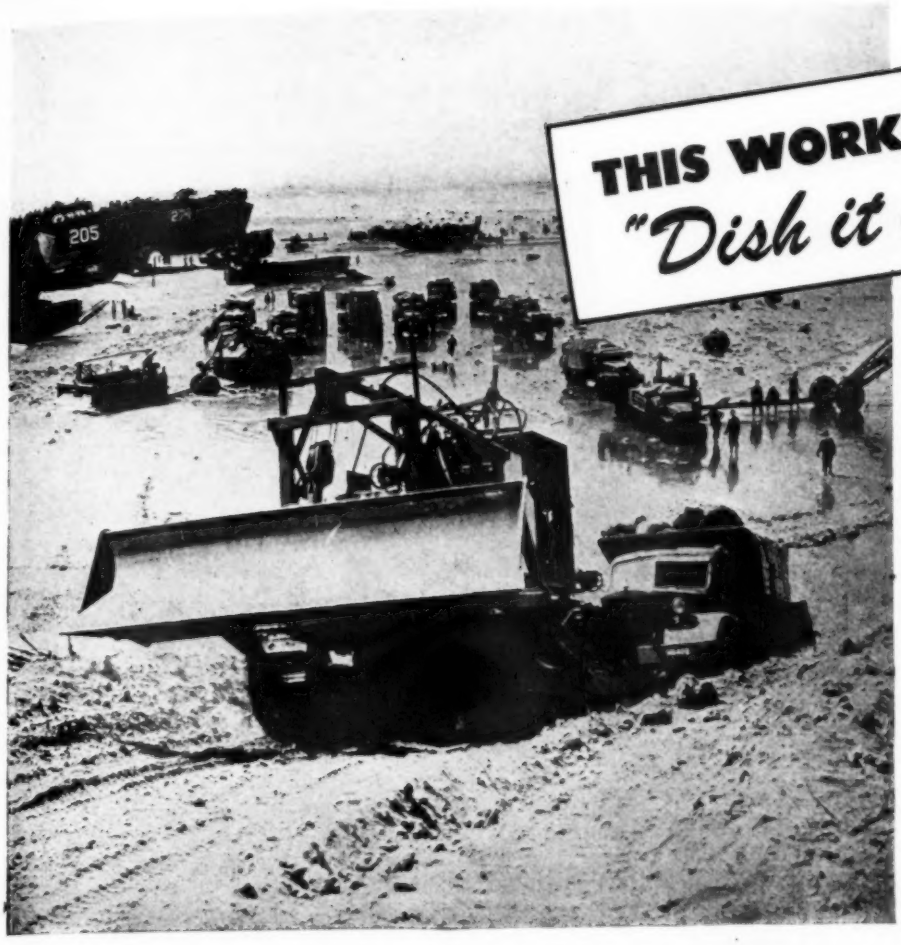
The typical renovation procedure is as follows: (1) Ammunition is received at Redstone from a port of entry and segregated by lot and type. (2) Ballistic samples are sent to the proving ground for determination of quality. (3) On basis of proving-ground findings, renovation takes place. This may include all or part of the following: replacing fuzes, bursters, propellants, packing, repainting, or remarking. (4) Finished production must meet all requirements of new ammunition. (5) The product is then shipped as new ammunition.

Redstone Arsenal has been charged with the responsibility of renovating all Ordnance chemical ammunition returned to this country. It is expected that this program will continue well into the postwar period.

The arsenal has its own proving ground for proof-testing for acceptance certain ammunition and components manufactured by the arsenal and performing experimental firing of certain chemically filled Ordnance ammunition for research and development purposes.

The number of employees at the arsenal exceeded 4,500 at the peak during last winter. Some production lines have as high as sixty-five per cent women employees. When the average Southern worker came to the arsenal from the surrounding farm country his adaptability to the various types of work involved in the manufacture of munitions was questionable. However, there are few areas in the United States where the competence of a worker group has risen so far in so short a time.

The commanding officer of Redstone Arsenal is Col. Carroll D. Hudson, a veteran of World War I, who was in command during the development of plans and the construction of the arsenal and has continued in command since its inception.



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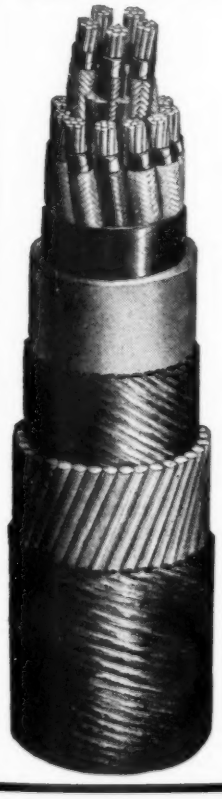

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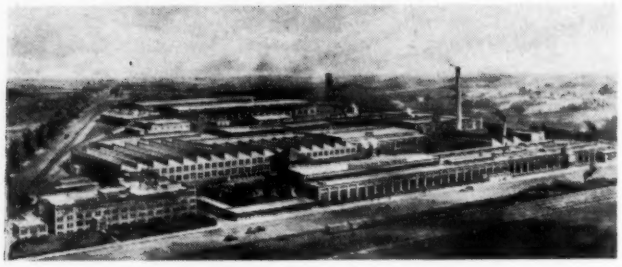

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Automotive Maintenance

OFFICE, CHIEF OF ORDNANCE—DETROIT

The front-page headline on the Detroit newspapers of September 1, 1942, read: "Rommel Strikes Out for Nile Valley; Drives 8 Miles through Mine Fields." On page 3, a modest 3-paragraph article announced the opening of a new Army Ordnance organization known as the Tank-Automotive Center (TAC). It was taking over Detroit's Union Guardian Building skyscraper for its offices. On January 1, 1944, Detroit newspapers told of TAC's rechristening as "Office, Chief of Ordnance—Detroit."

One hundred and seventy new items that were once OCO-D development projects have been designated either as limited procurement or standardized. Most widely publicized of the recently standardized major items is the new General Pershing heavy tank M26. But development activity has not been exclusively concerned with tanks. It has included all combat vehicles and their armament as well as transport vehicles and components such as power plants, tracks, suspensions, transmissions, rubber products, and special equipment.

From its thousands of partners on the Industry-Ordnance team, OCO-D has accepted 4,032,968 major items valued at more than $20,000,000,000. Along with each new vehicle came a supply of spare parts that were to be used in keeping these vehicles rolling across Italy, France, Germany, and the myriad islands of the Pacific.

Always on the alert to save the taxpayers' money, OCO-D has used both Army and commercial facilities to remanufacture vehicles and return them to service at about one-third of their original cost. Some idea of the size of this operation can be gained from the fact that the commercial facilities' remanufacturing budget of $2,958,000 in 1943 has soared to an estimated $162,361,000 in 1945.

THE general supplies handled by the 39 storage depots under OCO-D supervision during December 1942 totaled 526,000 tons. In the first two months of 1945 they handled 1,888,909 tons. Alert, progressive supervision also increased the number of tons handled per 8-hour man-day in warehouse and shed areas from 1.35 in January 1944 to 2.20 in March 1945 and from 5.77 tons to 10.75 tons in open areas.

Keeping the right vehicle and the right one of the 125,000 different kinds of tools and replacement parts where it is wanted, when it is wanted, and in the quantity desired, is another of OCO-D's tasks. It is perhaps the largest stock-control job in the world. Independent stock positions are maintained and constantly surveyed on each of the 125,000 tools and parts. Line-item activity is one measure of the size of this job. During an average month OCO-D receives and processes 215,000 line items.

So that the soldier using OCO-D vehicles might be armed with the skill to keep them in prime condition at all times, OCO-D has sent thirty-eight missions into the various theaters of operations and given the same maintenance instructions to forty-one combat organizations while they were training in the United States.

To redistribute the equipment made excess by the shifting demands of war so that it might lend the greatest support to our war effort and civilian economy has been another of OCO-D's jobs. Between January 1, 1944, and March 31, 1945, it has redistributed 110,273 line items and 78,406 vehicles having a dollar value of $148,843,369 and weighing 197,488 tons.

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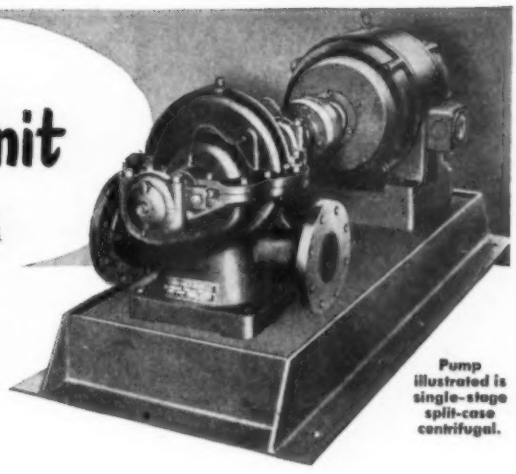

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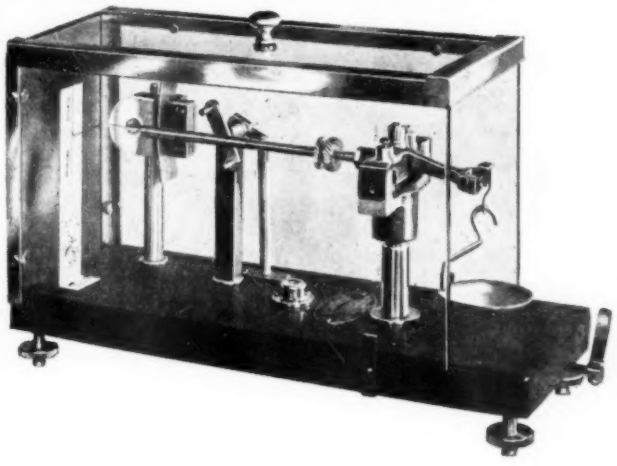

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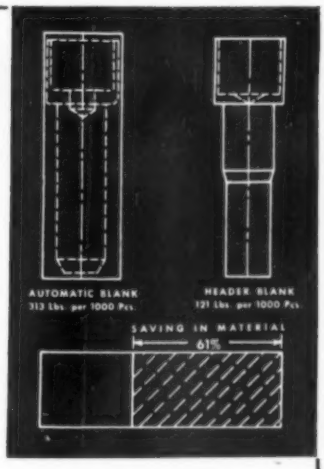

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Machine Guns

U. S. Machine Guns, 1895-1944, Part II

Maj. B. R. Lewis

THIS is the second of a series of articles on machine guns of the United States being written for ARMY ORDNANCE by Major Lewis. When finished, this will be the only complete and authentic account ever published which lists and describes *all* the official models of U.S. machine guns from the first caliber .30 weapon up to 1944. Part I, which appeared in the July-August issue, treated of machine guns from the Gatling to the Marlin Model 1918 tank gun. The present installment continues this story of development.—EDITOR.

Vickers 11-mm. Aircraft Gun, Model 1918.—During World War I the development of larger caliber machine guns was initiated when a need arose for an efficient incendiary cartridge more effective than those of rifle caliber against balloons and aircraft gasoline tanks. By 1917 the French developed a tracer-incendiary bullet for their old Gras 11-mm. cartridge, Model 1874. They modified Hotchkiss machine guns to handle this new ammunition. At about the same time the British changed their Vickers machine gun to handle their old caliber .45 Gatling cartridge, which gave the maximum permissible chamber pressure in the caliber .303 gun.

It was highly desirable to have the new guns interchangeable with existing synchronized types in order to avoid complicating the already serious airplane-production program. Hence, with this consideration in mind, the Signal Corps requested early in 1918 that 1,000 Marlin guns be adapted to use the 11-mm. French cartridge which was already being made in the United States for the French Government. As a major redesign appeared to be necessary for a satisfactory conversion of the Marlin gun, it was decided to try the Vickers caliber 7.62-mm. gun being made by Colt for Russia. This functioned well in the larger caliber, and some 800 of these guns, either completed or in process, were secured from Colt and modified for the 11-mm. cartridge.

Colt was given orders first for 1,700, then for an additional 1,875 new Vickers guns to be made for the 11-mm. cartridge.

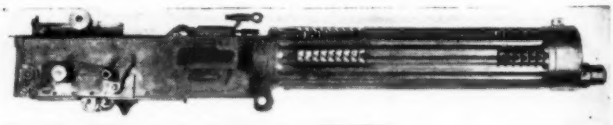

Fig. 9. Vickers 11-mm. Aircraft Machine Gun

This gun was designated the Vickers 11-mm. Model 1918 (Fig. 9). It fired between 500 and 600 rounds a minute, with an effective incendiary range of 1,850 yards. It was a substitute standard until perfection of the caliber .50 gun. On March 28, 1929, 2,070 of the 11-mm. guns with 1,500,000 rounds of tracer incendiary ammunition were declared obsolete.

Browning 11-mm. Aircraft Gun, Model 1918.—On request of the Air Service, in 1918 the Ordnance Department started development of an 11-mm. Browning aircraft machine gun for use in the same manner and for the same purpose as the Vickers 11-mm. gun on those planes to be equipped with Browning caliber .30 guns. When an 11-mm. gun was needed, it was to be installed in place of one of the two usual caliber .30 Brownings. A water-cooled Browning gun, caliber .30, was altered to use

Major Lewis is assigned to the historical section, Office of the Chief of Ordnance.

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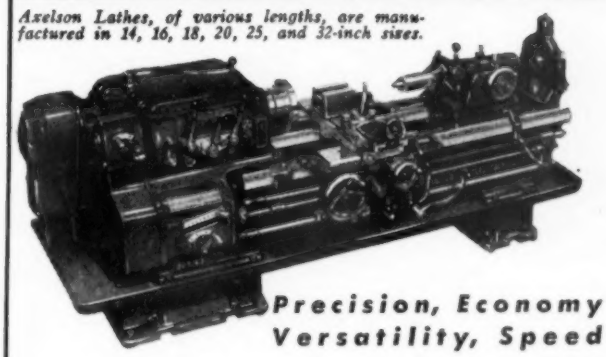

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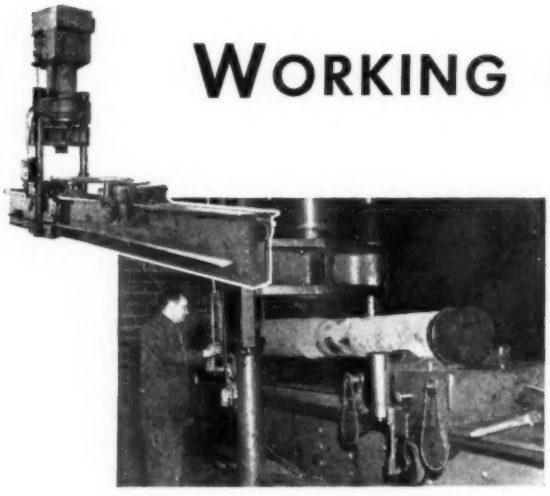

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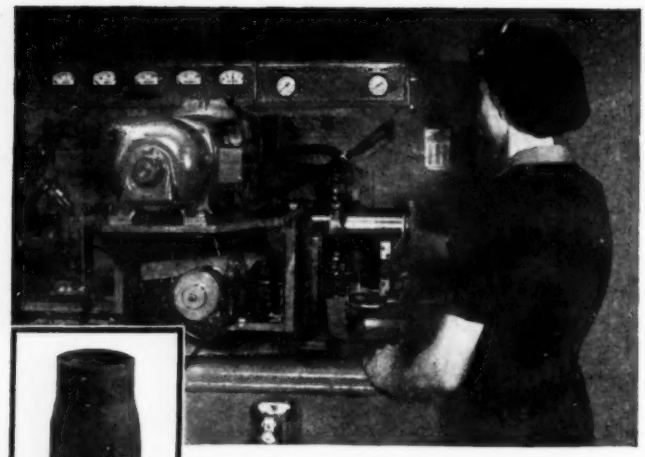

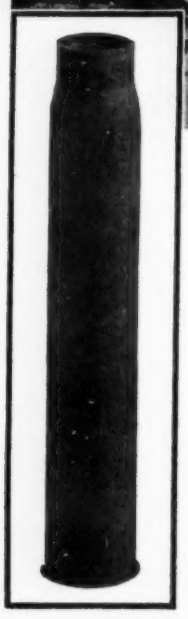

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The illustration shows the simplicity of examination of the bore of a .50 calibre machine gun barrel.

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Machine Guns

11-mm. ammunition and was satisfactorily test fired. An experimental order was placed with Colt for eight 11-mm. Browning machine guns. This type never went into production.

Caliber .50 Machine Gun.—In 1918 the attention of the Allies was directed to the need for more powerful armor-piercing projectiles for small arms for use against tanks and armored airplanes, which were commencing to appear.

In the spring of 1918, the British started to develop a caliber .50 cartridge—eventually the caliber .50 Vickers. General attention was focused on this problem when Quentin Roosevelt, son of ex-President Theodore Roosevelt, was shot down in an aërial combat with an armored German plane. General Pershing cabled in April 1918 that the British caliber .50 development program was coming along very slowly and that a caliber .50 machine gun for both air and ground use should be developed independently in the United States. He recommended use of a bullet of about 670 grains and a velocity of 2,700 feet a second.

Winchester Repeating Arms Company, New Haven, Conn., was asked to develop a cartridge to meet these requirements, and Colt was asked to work with John M. Browning to produce a machine gun to handle it. The first caliber .50 ammunition made by Winchester was a "scaled-up" version of the .30-'06 cartridge, but with a rimmed-type case. This was first fired in a clip-fed,

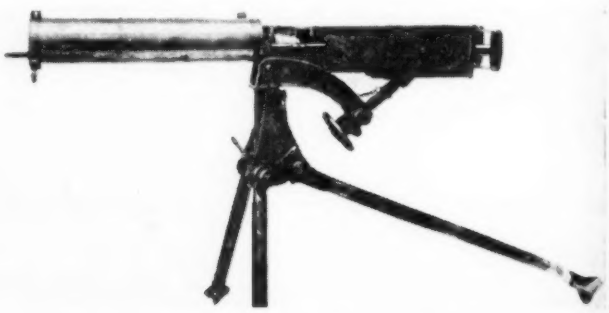

Fig. 10. Original Caliber .50 Water-cooled Browning

bolt-action, antitank or sniper's rifle made by Winchester in the summer of 1918. On July 18, 1918, General Pershing sent a cablegram asking that the caliber .50 case be of the rimless type.

Winchester sent a dummy caliber .50 cartridge to Colt when the approximate ballistics had been worked out, and a water-cooled gun (Fig. 10) was made up under Mr. Browning's supervision. Mechanical features were about the same as those of the caliber .30 Model 1917 gun.

To facilitate cartridge and gun development, the gun was sent to Winchester on September 7, 1918, where experimental firing continued under the supervision of Mr. Browning. On September 10th, Winchester was instructed to make six aircraft guns, pushing one to completion as rapidly as possible. About September 12th, a complete set of components for the water-cooled gun and some partly finished components for the aircraft gun were sent to Winchester by Colt. Based on these, Winchester commenced a complete set of drawings for the aircraft gun, redesigning the mechanism to introduce such changes as were necessary to facilitate manufacture or to correct functional defects brought out in the firing.

On October 15, 1918, the first water-cooled gun fired 887 shots in bursts of 100 to 150 rounds. The 5¼-inch cartridge, with 707-grain bullet, developed a velocity of 2,369 feet a second. Based on this test, the Engineering Division, Office of the Chief of Ordnance—now the Small Arms Division—recommended that Winchester be given an order for 5,000 air-cooled and 5,000 water-cooled guns with priority placed on the former type.

The components of the first aircraft-type gun (Fig. 11) were assembled on November 12, 1918. It had a 30.5-inch barrel, the longest which Winchester was equipped to rifle. With the Armis-

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Federal 1½" Caliber Gas Gun fires shells pictured below.

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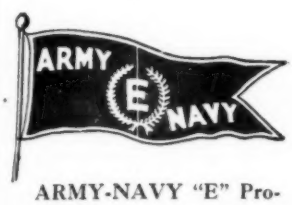

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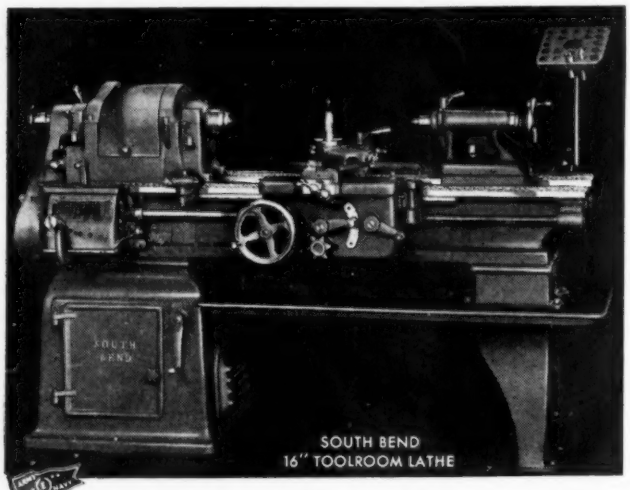

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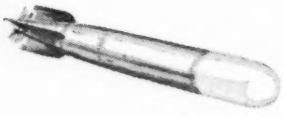

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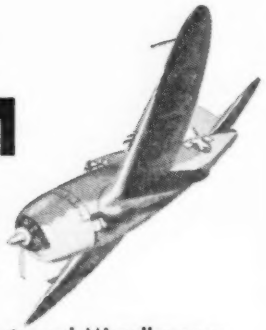

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tice, work on the remaining five guns of the original order—for which a formal contract was never given—was stopped, and no additional guns were ordered. Firing of the aircraft-type gun was delayed, as no firing mechanism was available. A trigger motor was finally provided, and the gun was test fired by Mr. Browning at Aberdeen Proving Ground, Md., on November 24th. This test was successful, and the gun and drawings were turned over to the Government.

About December 1, 1918, the Ordnance Department decided that all future development of the special aircraft ammunition for this gun should be carried on at Frankford Arsenal instead of at the Winchester plant. Characteristics of the components for regular service ammunition in this caliber were, on the other hand, to be established by the Winchester Repeating Arms Company, and Winchester continued to furnish the original type of caliber .50 ball ammunition to the Government through 1919.

WHEN war was declared on April 6, 1917, the United States Army had 670 Benét-Mercié Model 1909 machine guns; 285 Maxims Model 1904; and 350 Lewis ground-type guns, chambered for the British caliber .303 cartridge. On our entry into the war there was only one facility in the country equipped to manufacture caliber .30 machine guns. The Savage Arms Corporation, Utica, N. Y., was nearing completion of 12,500 caliber .303 Lewis guns for the British and Canadian Governments, at the rate of about 80 a day.

The Marlin-Rockwell Corporation, New Haven, Conn., had completed a Russian contract for caliber 7.62-mm. guns of the old Colt type. Their production had reached a rate of about 300 a day. Colt's Patent Fire Arms Manufacturing Company, Hartford, Conn., was producing Colt guns in limited quantities and was tooling up for production of caliber 7.62-mm. Vickers guns for Russia. They were also working on an order from the United States Government for 4,125 Vickers guns for the caliber .30 cartridge. These were the only facilities in the United States prepared to manufacture machine guns of any kind.

On April 12, 1917, the War Department ordered 1,300 Lewis guns from Savage for training purposes in the United States. The Ordnance Department had found the Vickers gun very efficient and decided to keep it in manufacture. After adopting the Browning gun in May 1917, the Government began development

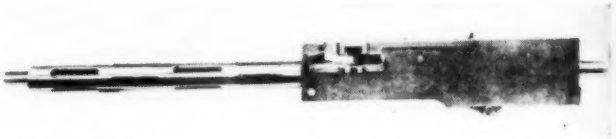

Fig. 11. Original Caliber .50 Air-cooled Aircraft Browning

of large manufacturing facilities in order that the required numbers could be produced in the time specified. The Colt Company prepared the necessary drawings and gages for quantity production.

In July 1917, orders for Lewis guns were increased. In September, orders for 15,000 Browning Model 1917 guns were placed with the Remington Arms Company, Bridgeport, Conn., and for 5,000 with the Marlin-Rockwell Corporation of New Haven. In December 1917, an additional 10,000 guns were ordered from Marlin-Rockwell. Remington was later given an order for Browning aircraft guns. In January 1918, the New England Westinghouse Company, Springfield, Mass., received a contract for Browning water-cooled guns, and the Remington contract for aircraft guns was transferred to them.

DURING 1917, cablegrams from General Pershing indicated an urgent need for a large production of aircraft machine guns in both fixed and flexible types. He emphasized the Allies' experience which had demonstrated that the Vickers gun was the

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Machine Guns

only one satisfactory for synchronizing with propellers, and he recommended that the U. S. procure as many of them as possible and use the Lewis gun in a flexible mount. In the same communication, he urged the use of four machine guns for each airplane and suggested consideration of the use of six guns in the future. At the end of the war, quadruple mounts were being developed.

The Vickers, though difficult to manufacture, reached a production rate of over fifty a day by May 1918. For synchronized use, two satisfactory guns, the Marlin and the Browning were developed. The Marlin, based on the old Colt, by September 1917 had been improved so much that orders were placed for 23,000 and later increased to 38,000. Preparation for production was well under way by the end of 1917.

Following General Pershing's instructions, the large orders for Lewis guns were changed to aircraft type. As expansion of the Savage plant was capable of handling the aircraft requirements, there was no need to extend manufacture of the Lewis gun to other facilities. By May 1918 the Savage Arms Corporation had produced over 16,000 of these; by the end of the war this total had been increased to about 32,000, in addition to some 6,000 delivered to the Navy.

By May 1918 the Marlin-Rockwell Corporation had made nearly 17,000 Marlin aircraft-type guns. Their entire contract—38,000 Model 1917—was completed by October 1, 1918. Production was ahead of requirements at all times.

The Colt Company delivered over 2,000 Vickers guns by May 1918, and by the Armistice over 9,000 ground-type and 5,000 aircraft-type guns had been completed. The 1,000 Russian Vickers guns contracted for with Colt were taken over by the United States; by the Armistice, most of these had been modified to 11-mm. In September 1918, the rapidly increasing output of the new Browning guns caused cessation of production of the ground-type Vickers.

In January 1918 the New England Westinghouse Company was given orders for Browning heavy guns; by the end of April 1918, they had produced eighty-five. By the middle of May, the Remington Company was also in production on this gun, and Colt began deliveries in June. By the Armistice, a total of 43,000 Brownings had been completed, of which 41,348 were shipped overseas. Orders for 100,000 of these guns were placed, but after November 11, 1918, this total was reduced by 32,500.

During 1918, the design of a Browning tank gun was undertaken and an order given to Westinghouse for 40,000 of these. It is significant that this basic design was used in the 1919A4, A5, and A6 guns, all of which have established an enviable record in World War II. Deliveries of 7,000 a month were scheduled to start in January 1919. By the end of the war, only sample guns had been produced and, in line with the curtailment of tank production, the order was cut to 500.

Since the Marlin and Vickers guns had proved satisfactory, and the Browning ground-type gun was more urgently needed, development of the Browning aircraft machine gun was not pushed. Only a few hundred aircraft-type Brownings were delivered prior to the end of the war.

MACHINE-GUN development and production was one of the best performances of the Ordnance Department and United States industry during the first World War. In a year and a half the output rose from practically nothing to 1,600 a day. On April 6, 1917, the U. S. Army possessed a total of about 1,600 machine guns; on November 11, 1918, it could count more than 233,000. Of these, 185,000 had been made in the United States at a rate of production far higher than that reached by any other country.

Cost of the guns manufactured during World War I, less parts and accessories, varied from $239.89 for the ground-type Lewis to $600 for the Colt. The Browning water-cooled gun cost $283.52 and the aircraft type $251.50. *(To be continued.)*

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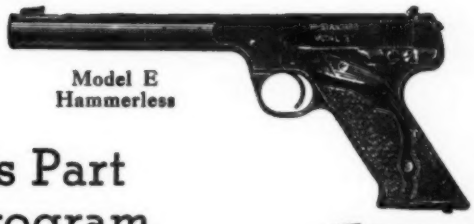

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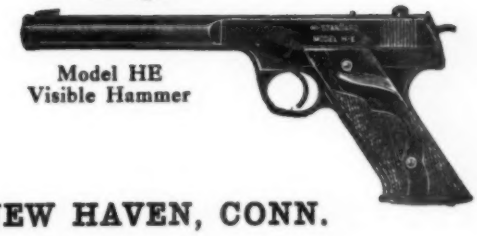

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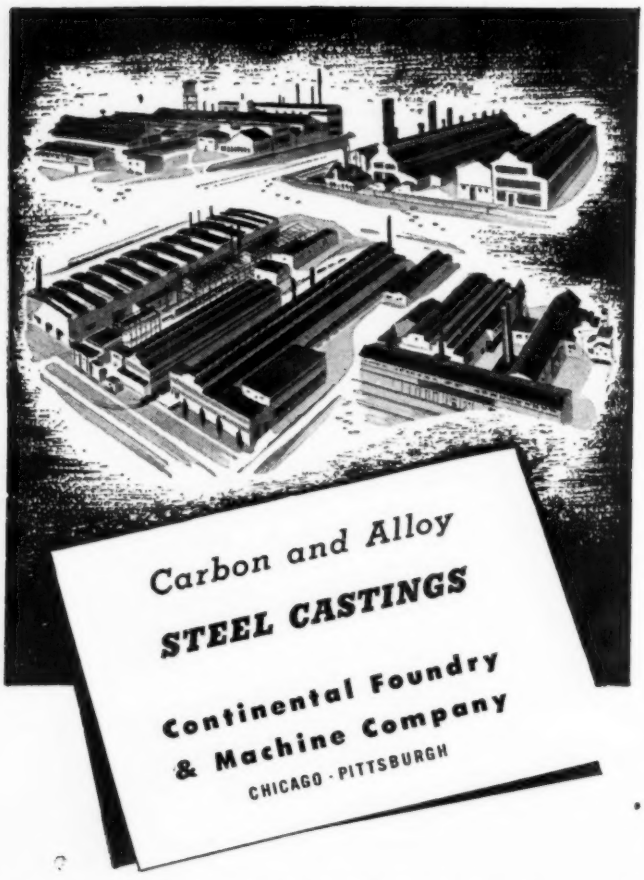

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From The Record

NAVAL AMMUNITION REQUIREMENTS

To meet the increasing ferocity of Jap resistance successfully and still keep loss of American life at a minimum, we must and intend to be prepared to concentrate unprecedented firepower against points of resistance. The faster we pour ammunition at the Japs, the more American lives we will save. The Navy has been preparing for this. Production figures tell the story. In 1942, we averaged $29,210,411 a month for all types of ammunition. But this year, when production reaches its peak, we will be turning out each month about $240,000,000 worth of ammunition to hurl at the Japs. Roughly, a third of this will buy rockets, a third ammunition for guns, and a third torpedoes, depth charges, mines, and pyrotechnics.

Even though we can train all our guns on a single enemy, it does not simplify our problem. Iwo Jima and Okinawa have given us merely a foretaste of what to expect. The Japs are fighting with increasing fury. To subdue them unconditionally will take firepower such as the world never before has known. It is our job to see that the fleet has such firepower.

Right now one big and growing job in Ordnance is repair and maintenance of the guns and mounts we have; a second is adding to our ships new and improved weapons and control devices coming from continuous and intensive research; and the third is providing the ammunition. Our requirements for expendables—the ammunition—are constantly going up. We'll need plenty more for the big battles we can see ahead. In other words, now we have the razors, but we need lots of razor blades!

Each battle varies, of course. But expenditures in the recent major campaigns of the Pacific will give you some idea. At Tarawa, the Navy used 3,000 tons of gun ammunition. The Marshalls took 16,000 tons. In the Marianas, we fired 36,000 tons before Tinian, Guam, and Saipan were ours. It required 16,000 tons to subdue little Iwo Jima. And at Okinawa 34,000 tons were fired in the first 48 days. And bear in mind that these places, although strategically essential, are only the outposts. As our offensive drives into the Japanese homeland, we must expect fanatical, suicidal resistance. Obviously, to overcome it we must hurl more shells and rockets and bombs at the Japs than ever before. For example, let me tell you about the action of one light cruiser off Okinawa. In 60 days she blasted the enemy with over 13,000 rounds of 6-inch ammunition and an equal amount of 5-inch ammunition. Now consider that all the ships of our fleet mount 85,600 guns—from 20-mm. to 16-inch—and it is readily apparent that we must have tremendous quantities of ammunition, workers to make it, and money to pay for it.

New construction needs are in hand, but improvements and repair and maintenance are vital. The barrels of the larger guns, from 8-inch to 16-inch, can be relined. The others must be replaced. When they don't escape battle damage, it calls for a major repair job such as is now being done on the FRANKLIN, the carrier the Japs boasted they had sunk. They didn't sink her, largely because a gallant crew brought her back. What's more, the FRANKLIN will be ready to resume battle soon because skilled workmen will send her out again, good as new. But it's going to take an estimated 6,500,000 man hours of work—200,000 of them for ordnance repair—to do it. There are other damaged ships coming, few damaged as severely as the FRANKLIN, and they are badly needed in the Pacific. I cannot stress too

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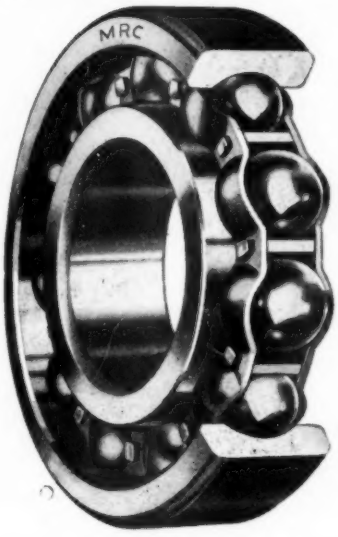

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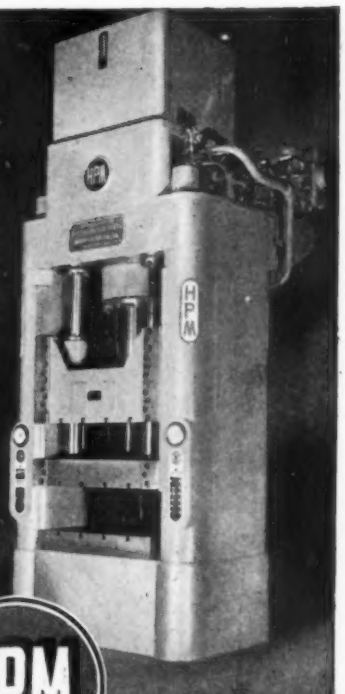

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From the Record

strongly the critical need for workers, especially those in the electrical trades, to put these honorably scarred ships back in fighting trim.—REAR ADM. GEORGE F. HUSSEY, JR., *Chief of the Bureau of Ordnance, U. S. Navy.*

CIVILIAN-MILITARY SCIENCE

We had some experience with the attempt in World War I to link civil science with the military. In 1914 to 1917 we in this country, military and civilians alike, were amateurs in modern technological warfare. Civilians had no experience whatever, and our own military people, thanks to our military policy, had had very little. So we started back at scratch, along in 1915 and 1916 when those storm clouds began to gather, to see what we could do.

It was recognized pretty generally, and the experience in Europe had indicated quite clearly, that applied science was a controlling factor in a modern war. We hadn't any experience, and World War I didn't last long enough, as far as we were concerned, to really prove whether we had made any real progress or not. Then there followed fifteen years of national anti-militaristic attitude, and there wasn't very much done.

When the storm clouds began to gather in 1939, civilian scientists and the military alike began to get very interested in how, should we be drawn into this conflict, we were going to utilize this great civil potentiality of ours for military purposes. To make a long story short, the military organizations began to increase their research and development staffs, partly by taking technically trained men, scientists, and engineers into the uniformed service and partly by taking them in as civilians.

In addition to that, we in the civil field set up first the National Defense Research Committee, and then a year later we set up the Office of Scientific Research and Development which took in both the National Defense Research Committee and the Committee on Medical Research. At the start it was frankly designed to be a research organization which would undertake to explore the longer range possibilities of science, carry them to a certain point, and then turn them over to the military.

What we did was to commandeer, between the military and OSRD organization, practically every top-line and most of the second- and third-line scientists of this country. We took them out of their national habitats, perhaps not physically, but we took them out of their natural peacetime occupations, and turned them all into industrial scientists.

We paid an awful price for what we did, because we stopped the production of fundamental knowledge, and we stopped the training of scientists; but we created, between the military and the OSRD, the greatest industrial research organization the world has ever seen.

While it wasn't, like all new organizations, a very efficient organization measured by normal standards, it did produce, along with a few duds, some very astounding results. Most astounding of all, to me at any rate, was the fact that some of the most fundamental scientific people showed their capacity for adaptation by becoming effective industrial scientists.

This is a striking illustration of the adaptability of men who are thoroughly trained in science or engineering to meet almost any sort of problem that may be put up to them.

About a year ago we began to get a little bit worried about what was going to happen in the postwar years. Every one was agreed, military and civilian scientists alike, that the coöperation which has been established through these war years had shown not only the value of that coöperation with the military for national security but also the many ways in which results could be accomplished.—DR. F. B. JEWETT, *chairman, Bell Telephone Laboratories, and president, National Academy of Sciences, before the Aberdeen Proving Ground Post of the Army Ordnance Association.*

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ORDNANCE IN REVIEW

The Gewehr 43 Semiautomatic Rifle

Melvin M. Johnson, Jr.

GERMANY has been overwhelmingly defeated, but the technical developments of the Reich remain of great importance to all those responsible for the unceasing improvement of ordnance. The sooner we of the United States can learn simultaneously to despise the enemy yet respect his technical achievements the better the future security of such a target nation will be in a vicious technological modern world.

In the field of small arms, the German Gewehr 43, caliber 7.9-mm., is the latest semiautomatic rifle, and, with the MP43 (KAR44), described in the March-April 1945 issue of ARMY ORDNANCE, the latest and last-distributed German automatic weapon.

To those familiar with the general development of semiautomatic rifles, the background of the Gewehr 43 is significant. Its predecessor, the Gewehr 41, trapped the actuating gases at the muzzle and, through a short-stroke gas rod, forced rotation of a turning bolt to effect unlocking. The Russians had already developed the M1936 Simonov semiautomatic, followed shortly by the Tokarev. A separate discussion of these weapons is appropriate, but it must be observed here that the Tokarev incorporates certain basic features which have been followed in the Gewehr 43. The locking system is similar to the Russian Degtyarov LMG, originally patented in Germany as early as 1909.

The German MG42 (1942) used this folding or hinged lug system, and the Gewehr 43 incorporates this type of locking with a gas port approximately nine inches from the muzzle of a 22-inch barrel, thus relatively avoiding the fouling problem which results from muzzle gas ports.

It may be seen, therefore, that the Germans were willing to copy functional features of various other weapons from a typically practical point of view. Moreover, it is significant that the Russian Tokarev semiautomatic supplied the major inspiration for this final German design. Who prior to 1941 would have imagined the Germans copying from Russia in 1943?

The Gewehr 41 weighed nearly eleven pounds. The Gewehr 43 weighs 9.75 pounds with its 0.25-pound sling, 0.4-pound magazine, and the typical half-section Mauser cleaning rod in the forestock. With 22-inch barrel, the over-all length is 43.5 inches. Unlike Gewehr 41, the 10-shot box magazine is detachable from the bottom. Unlike the Russian Simonov, there is no provision for full-automatic fire nor is there any bayonet attachment.

From the standpoint of comparative weight, the Gewehr 43 is one of the lightest of the various semiautomatics. This is due partly to its 7.9-mm. cartridge (0.15-inch shorter than ours) but especially to the lightweight wood of the stock and the flimsy metal stampings used. Unlike our well-oiled walnut stocks, the cheap German (probably) cedar stock is dry. For use with a telescope the Gewehr 43 is loaded by magazine from underneath, permitting central scope mounting. Otherwise it may be loaded (like the British SMLE rifle) by Mauser clips from the top, bolt open.

The action has several interesting features. The gas piston

Melvin Johnson is the author of "Rifles and Machine Guns of the World's Armies"; coauthor, "Automatic Arms," "Ammunition," and "Weapons for the Future." He is the inventor of the Johnson light machine gun and the Johnson automatic rifle. He is a captain in the U.S. Marine Corps Reserve on inactive status.

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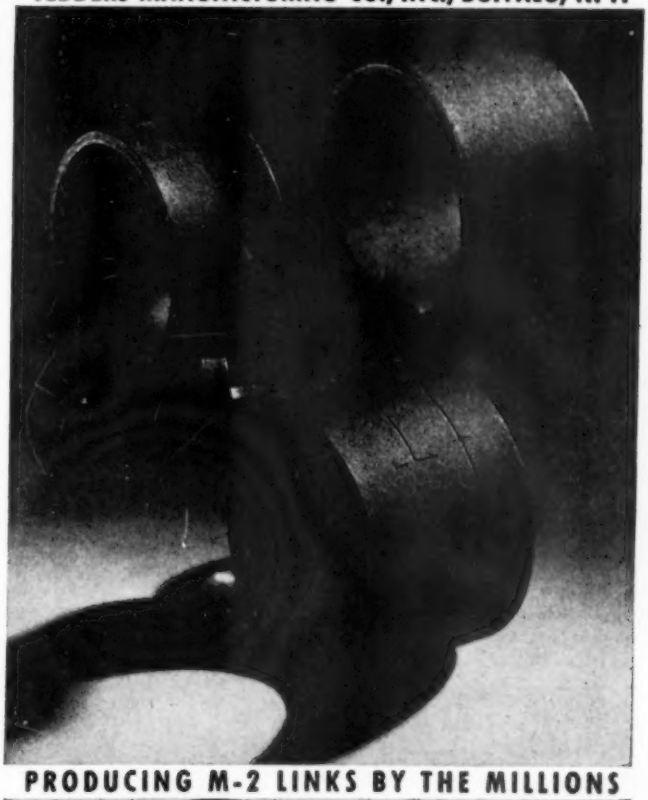

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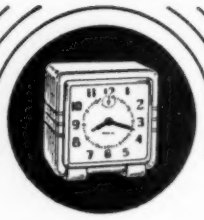

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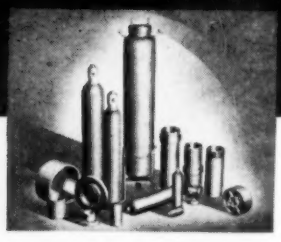

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and shaft are on top of the barrel, protected by the removable wooden hand guard. The gas piston and cylinder assembly consist of the fixed piston base and piston plug four inches long with internal gas hole. Unlike conventional gas-operated weapons, the cylinder of the Gewehr 43 is the moving member, nearly four inches long, telescoping over the fixed piston plug. Consequently the gas which is ported nine inches from the muzzle and ten inches from the chamber must pass through the 4-inch piston plug before impinging on the sliding cylinder head.

The operating-shaft extension stem is seated in the rear of the cylinder, joining it with the operating shaft which carries a seat at the forward end, serving as a shoulder for the operating-shaft return spring. The operating shaft passes through the rear sight base to contact the operating-slide housing. This assembly is dismounted by compressing the main operating shaft, removing the extension stem, pulling the operating shaft forward, then sliding the cylinder rearward from the gas piston. The total cylinder and operating-shaft stroke is three inches. The total bolt stroke is 5.3 inches.

The operating-slide housing completely encloses the breech aperture when forward. When driven back by the gas-actuated shaft, the operating-slide housing actuates the bolt carrier which

The Gewehr 43 field-stripped.

cams the hinges of the two lateral bolt locking lugs, forcing the lugs inward from the receiver abutments, thus unlocking the bolt. The shaft follows through about two-thirds of the opening stroke and then stops. It is returned to battery by its return spring.

The operating-slide housing with bolt assembly continues rearward against the rather light mainspring. The spring-loaded ejector stationed in the receiver hits the empty shell through an angular slot cut in the bolt head. This is the Mauser-type ejection principle. The mainspring then forces the bolt home, chambering a fresh cartridge. The operating-slide housing, against which the mainspring operates, finally cams the hinged bolt lugs out laterally into their recesses in the receiver via the bolt carrier.

The firing pin is carried in the bolt carrier and is consequently withdrawn for safety by the operating-slide housing. The piece is fired by a separate hammer with double sear hooks of the conventional type. The firing pin consists of two pieces, the rear portion of which is retained in the carrier by a transverse pin. A spare firing pin, forward section, is carried in the butt trap, as well as a spare extractor claw. The assembled extractor is carried in the bolt head, actuated by a small coil spring and retained in slots in the bolt head by a slot-head plunger lock.

The receiver consists of a stamped frame. A stamped metal receiver cover is assembled to the back section. This is slotted longitudinally on top for passage of the operating-slide housing carrier lug which passes inside the metal receiver cover during the action stroke. Slots or ways on the metal receiver cover guide the slide housing which passes over the outside of the receiver cover in opening.

The above design is cheap to make. The entire action is covered when the bolt is closed, but the metal receiver cover surface is traveled over by the slide housing, and the entire bearing surface of this receiver cover is exposed to dirt, sand, etc. The

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action is entirely exposed on top during clip loading. Very little space is provided for the mainspring. The action is definitely sticky even under normal conditions. The mainspring is decidedly weak. On the forward stroke, when friction should be avoided to assure easy feeding, the operating slide forces the hinged bolt lugs outward against the receiver frame causing considerable binding.

Obviously the hinged or folding locking lugs function. A sample Gewehr 43 was fired briefly, and it worked. The lugs did not cause trouble, but the receiver frame assembly was definitely flimsy. A crack was seen in the bolt carrier. The metal is much too thin in the carrier and bolt. Mechanically, the design is cheap and flimsy although clever and ingenious. The empty shells were ejected powerfully, and the rifle was respectably accurate at one hundred yards.

The cocking handle is on the upper left (offset) of the operating slide. A catch on the right permits holding the bolt open. The safety lug is a rotating lever at the rear of the receiver—right for safe, left for fire. The trigger guard is unusually large: it was very cold for the Nazis in Russia during 1941-1944, and a heavy glove can be used in firing the Gewehr 43.

The Gewehr 43 gas-rod assembly is removed by taking off the hand guard which is retained by the upper band through a simple spring latch. The band often sticks badly when the stock is wet. By pushing the shaft rearward, the stem can be removed, and the operating-shaft assembly then pulled out forward—the cylinder being drawn off rearward.

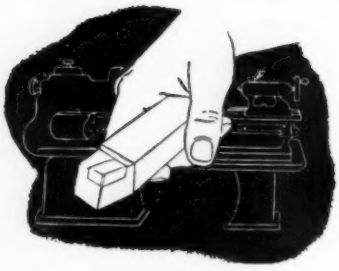
This need not be done to remove the breech mechanism. That disassembly is accomplished by engaging the breech mechanism in the open position with the breech catch, safety on. Next, the spring plunger in the rear of the receiver is pressed inward and the breech assembly raised upward from the rear out of the frame. The breech catch is released while holding the operating slide which is then allowed to move forward slowly. It is then lifted out of the bolt.

The mainspring is now released. The bolt carrier is removed rearward from the bolt and with it the firing-pin assembly. The 2-piece firing pin is removed by pushing the transverse retaining pin. The locking lugs now fall out of the bolt, and the hammer mechanism can be cleaned through the open frame. Two screws with lock screws hold the stock to the frame via the trigger-guard assembly.

IS the Gewehr 43 any good? Yes, in so far as certain design features are concerned. The gas system is very clever, as is the contact feature of the operating shaft. The action is fairly simple and easy to disassemble. The magazine and loading features are also simple and practical. But the Gewehr 43 is too cheap and too flimsy. An average U.S. Ordnance Department functioning test of perhaps 5,000 rounds or more probably would disclose many serious structural defects. This does not mean that it will not shoot up to a point—it certainly will. But the Germans had too little time to test out this weapon extensively. Making high-powered automatic weapons from stampings and low-grade materials sounds fascinating, but the results are far from adequate for a rugged, reliable weapon to be used in mortal combat.

What can we learn from the Gewehr 43 as to principles and trends in design? Chiefly, we see the tendency to put gas ports toward the breech where carbon deposits are reduced and port-hole plugging eliminated. Next is found an unlocking action in a gas-actuated weapon which offers relatively greater smoothness and ease of lug disengagement than obtained in earlier systems such as the much-copied Lewis. The Gewehr 43 lugs, compared with the Lewis system, are not thrust against the abutments by the action of the camming member on the lug hinges.

The locking and camming action is fully covered, at least when the gun is cocked and locked. This is most important for field service where rain and dirt often jam an exposed action.



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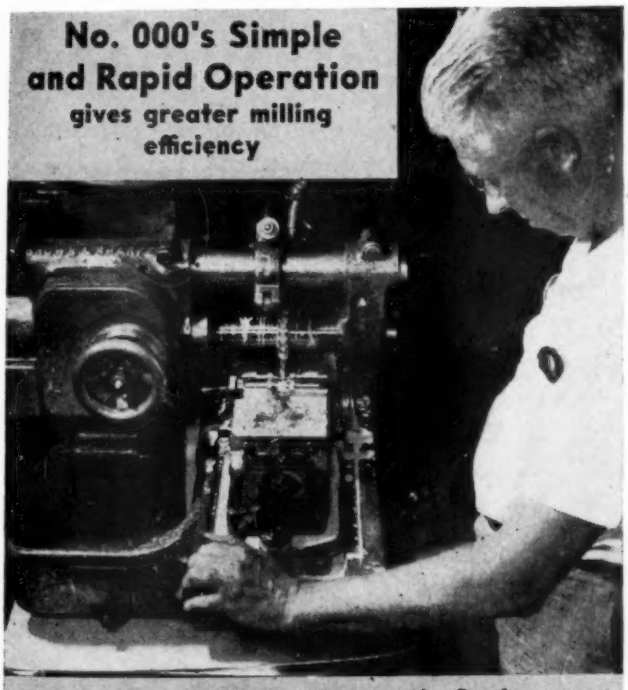

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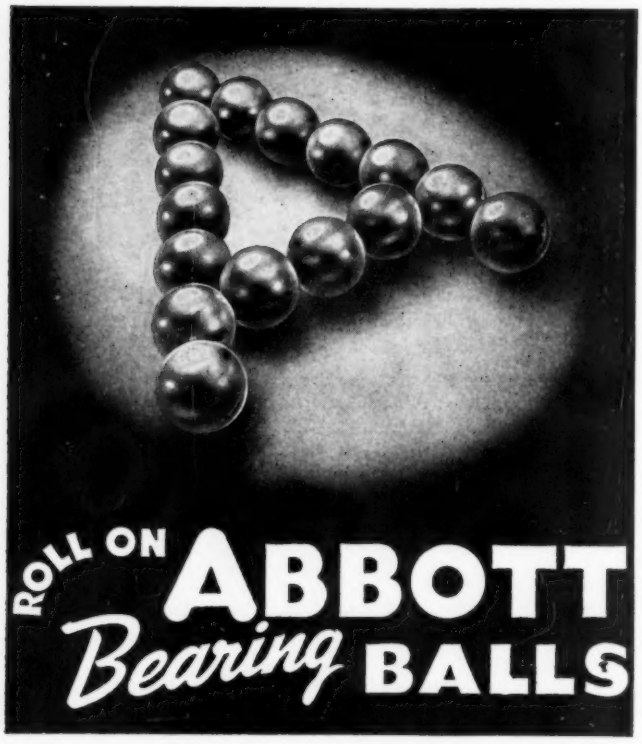

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BOOK REVIEWS

PRINCIPLES OF FIREARMS. By Maj. Charles E. Balleisen. New York: John Wiley & Sons. 146 pp. $2.50.

THE jacket of this little volume carries the following brief inscription: "For engineers and those requiring an up-to-date guide—with charts and diagrams—on engineering fundamentals essential for the accurate analysis, design, and construction of modern firearms."

As a brief and succinct epitome of Major Balleisen's work, the above cannot be improved. To amplify it a bit, the prospective buyer who is *not* an engineer but who still has good control of his college math need have no fear of its formulas.

The book is divided into eleven short chapters, almost all of which, praise be, terminate in bibliographies, and two appendices. After an initial chapter in the form of an introduction, the major discusses successively the gun barrel, recoil, automatic weapons (three chapters), trigger and sear mechanisms, cartridge feeds, sights, design problems, and the testing of weapons. The appendices are devoted to exterior ballistics and mounts.

The illustrations consist of fifty-five line drawings, most of which are as simple as they are effective. While highly schematic, they serve to illustrate their points much more clearly than would photographs or more elaborate artistic compositions.

WAR THROUGH THE AGES. By Lynn Montross. New York: Harper & Brothers. 941 pp. $5.

THIS book sets out to be a history of warfare from the days of early Greece down to our own times. It is well written, but the more serious and critical reader cannot avoid the feeling that the author never quite made up his mind as to the intent and purpose of the book.

Balance and unswerving impartiality are two necessary characteristics in any general history. The author gives too much space to historic phases which he liked or upon which he had more data. At times the accent is on military equipment rather than political history, and one feels that this subject might well have been a sufficient theme for the book.

WINGED PEACE. By Air Marshal William A. Bishop, RCAF. New York: The Viking Press. 175 pp. $2.75.

WHEN France and England declared war on Germany in 1939, Britain was starving for aircraft. To send the aircraft across from America involved dismantling, crating, a long hazardous sea voyage in which a large percentage was lost to submarines, uncrating, and reassembly in Britain—all requiring a period of four months. A meeting of American, Canadian, and British aviation experts turned down a proposal to fly the planes to England as impractical.

But when the bombing of England was at its height, a small group of businessmen met in a Montreal hotel. They believed that the bush fliers who conquered the northern wastes to supply mining camps could fly the ocean. The Canadian Pacific Railway loaned its ace bush flyer who went about the task of assembling crews. The first flight of "Hudsons" left Newfoundland on the night of November 10, 1940, and landed in Northern Ireland without the loss of a plane.

When this book was written, more than 11,000 planes had been flown across the North Atlantic. The author seems to think that this experience should be sufficient to confound the "experts" who now see the aircraft industry slipping back to littleness after the war.

(*Continued on p. 314*)

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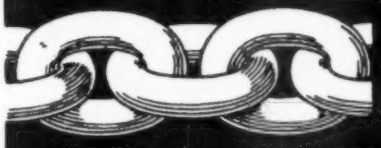

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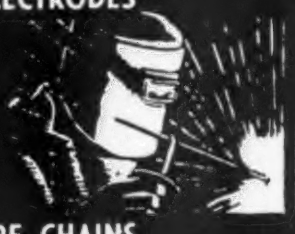

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Book Reviews

UNTIL THEY EAT STONES. By Russell Brines. Philadelphia: J. B. Lippincott Company. 340 pp. $3.

THE author of this book claims to have been an American newspaper correspondent in Hawaii and the Far East for ten years. He was in Japanese internment camps in the Philippines and in Shanghai. The publishers say of the book "This is modern history, accurately detailed and crisply written," but to this reviewer there is something "odorous" about it. It is no American saga of a man of Valley Forge or of the Alamo or of Bataan. The author did not go to Bataan with the men and women who made that historic stand. He remained in a hotel and was put in a concentration camp.

Finally he accepted a Jap invitation to volunteer to ride on the deck of a Japanese transport with plenty of food and buckets of hot tea. The Jap invitation was rejected by the hardier souls, of which his wife was one, who preferred to exist on the daily handful of rice rather than be a hostage for the safety of an enemy ship against American attack.

The Japs filled the decks by day with these volunteers whom the author admits included beachcombers and dope fiends. He excuses himself plausibly—he was going to Shanghai for news—but it is incredible that an experienced newsman did not know that the purpose of the American volunteers on the Jap deck was to ward off attacks of American bombers. This reviewer discounts the author's ideas on the Japs. The heroes of Bataan and Wake and Leyte asked no buckets of tea from their enemies. They had a secret weapon called "guts."

SUPERIORITY OF FIRE. By Maj. C. H. B. Pridham. London: Hutchinson's Scientific & Technical Publications. 146 pp. $2.10.

THE rôle of small arms in war during the past six centuries is ably and briefly reviewed by Major Pridham, with special emphasis on machine guns. In a chapter entitled "Machine Guns in Air Warfare," he analyzes the decisive part which fighter aircraft armed with multiple Browning machine guns played in the Battle of Britain. The machine-gun tactics of the World War are discussed. Though certain functions of this weapon have been delegated to long-range mortars, the basic principles for its use remain the same.

The story presented in this little book has deep significance. The British early learned the importance of rapid, accurate rifle fire. Influenced by French conceptions of volume fire, American doctrine has swung in recent years toward the "squirt-gun" theory as a substitute for adequate marksmanship. Here is a matter worthy of careful study in a nation dependent on a citizen army.

A few misstatements of fact are encountered, which do not detract from the over-all picture presented. Most of these errors appear to be based on use of European sources to the exclusion of American.

PRACTICAL MARKSMANSHIP. By Capt. Melvin M. Johnson, Jr. New York: William Morrow & Company. 183 pp. $2.50.

THIS book contains an understandable and comprehensive discussion of all the elements of small-arms marksmanship in their basic and more advanced phases. Commencing with the essential explanation of primary exterior ballistics, the reader is taken through a refresher course touching the high points of sight alignment, position, and trigger squeeze, finally expanding to an interesting analysis of the general requirements of getting hits in the field.

One of the striking qualities of this book lies in the author's unbiased and impartial explanation of certain marksmanship methods about which heated arguments are common. Hip firing with lighter small arms, for instance, is neither entirely denounced or condoned—all phases of the subject are logically enumerated, pro and con. Other equally debatable matters, such

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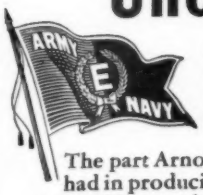

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INDEX TO ARMY ORDNANCE Vol. XXVIII

IS AVAILABLE ON REQUEST

The Index to ARMY ORDNANCE, Vol. XXVIII, with title page for binding, is now ready. It covers subjects in the January-February 1945 issue (No. 148), March-April 1945 issue (No. 149), and May-June 1945 issue (No. 150). It is arranged alphabetically by subject and author. Copies may be obtained, free of charge, upon written request.

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as proper types of sights, unorthodox firing positions, trigger pulls, and so on, are discussed in detail sufficient for the reader either to confirm or begin to question his previous personal convictions on the subject concerned.

This book is of such scope and detail as to be equally valuable to the infantry officer who is training his troops in any type of marksmanship firing, the hunter who desires positive results in terms of game, or the National Match rifleman who is after an elusive 20-V string in the Wimbledon.

STRONGER THAN FEAR. By Richard Tregaskis. New York: Random House. 144 pp. $2.

MR. TREGASKIS, the author of "Guadalcanal Diary," in this book turns to fiction to tell with unswerving honesty and reality the story of actual combat on the Western Front as it tests the soul of one man. The theme is the conquest of fear and the struggle of a group of men who, by their basic humanity, became good soldiers. Their courage in the face of always-imminent death and their self-doubts and questionings show that there are as many individual conflicts as there are men at the fighting front.

COMING, MAJOR! By Ezra Stone and Weldon Melick. Philadelphia: J. B. Lippincott Company. 267 pp. $2.

THE "Henry Aldrich" of radio's Aldrich Family program, now in the Army, has written this most interesting book on Army life. He was assisted by Mr. Melick, noted writer.

Ezra Stone relates his experiences in the Army, principally with the hilarious antics connected with his job of rounding up GI talent and putting on various theatricals, culminating with the association with Irving Berlin in his extravaganza "This Is the Army."

This book is full of scintillating humor and, combined with the clever illustrations by Ray Inman, the reader, especially the GI, is sure to roar with laughter.

THE TECHNIQUE OF THE TERRAIN. By H. A. Musham. New York: Reinhold Publishing Corporation. 228 pp. $3.85.

MAPS are one of the least publicized items used in this war, yet upon their accuracy depends the tactical success of every battle. This book will prove helpful for all those who may require a basic understanding of the principles of map construction and interpretation. Many a battle is won when a commander is able to deploy his troops in the dark through terrain he has never seen except as depicted on a military map.

The book is clearly written, with numerous sketches and diagrams. There are problems to work out as well as a complete set of tables and a cross index. A chapter deals with the relation of maps to logistics and aërial photography. The different systems used in making maps are explained and also the difference between the military maps of this country and those of foreign nations.

THE MILITARY INSTITUTIONS OF THE ROMANS. By Vegetius. Translated from the Latin by Lieut. John Clark. Edited by Brig. Gen. Thomas R. Phillips, U.S.A. Harrisburg: The Military Service Publishing Company. 114 pp. $1.

ORDNANCE service in the Roman Army was exceedingly well organized and had many interesting parallels with the methods of ordnance supply and maintenance today. Few military writers of antiquity, however, took the trouble to describe these technical services. It is therefore with great interest that we are able to examine the concise writings of Vegetius, who published his epitome of the military art toward the end of the fourth century, A.D.

At that time there was no separation of ordnance, quartermaster, and engineer functions. The chief of the technical services of the legion was an officer whose title has been rather in-

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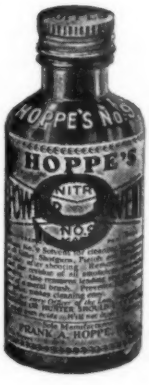

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adequately translated in the book as "Præfect of the Workmen." Vegetius tells us that under his command there were technicians and specialists such as masons, carpenters, blacksmiths, painters and "workmen of every kind for the construction of barracks in the winter camps and for making or repairing the wooden towers, arms, carriages, and the various sorts of machines and engines for the attack or defense of places." The mobile shop equipment of the modern ordnance maintenance companies had its ancient parallel, for Vegetius states that "they had also traveling workshops in which they made shields, cuirasses, helmets, bows, arrows, javelins, and offensive and defensive arms of all kinds."

HISTORICAL ARMOR (Third Edition). New York: Metropolitan Museum of Art. 32 pp. $0.25.

THIS is a brochure about historical armor on display in New York's Metropolitan Museum of Art with an introduction by Stephen V. Grancsay. It is illustrated and is of particular significance at this time when body armor has returned to the fray, not as artistically but more effectively than it was used in the sixteenth century. As Mr. Grancsay says, the armor reviewed "ranks with many of the finest harnesses of royal and noble personages and great captains in European national collections."

BOOKS RECEIVED

AIR POWER FOR PEACE. By Eugene E. Wilson. New York: McGraw-Hill Book Company. 184 pp. $2.

THE BEST FROM YANK, THE ARMY WEEKLY. New York: E. P. Dutton & Company. 304 pp. $3.50.

YOUNG MAN, YOU ARE NORMAL. By Earnest Hooton. New York: G. P. Putnam's Sons. 210 pp. $2.50.

WHAT TO DO WITH JAPAN. By Wilfrid Fleisher. New York: Doubleday, Doran & Company. 178 pp. $2.

THE PEOPLES OF MALAYSIA. By Fay-Cooper Cole. New York: D. Van Nostrand Company. 354 pp. $4.

THE PRISONER. By Ernst Lothar. New York: Doubleday, Doran & Company. 308 pp. $2.75.

A CIVILIAN'S DICTIONARY OF WARTIME ABBREVIATIONS AND ALPHABETICS. Detroit: Barnes-Gibson-Raymond Division of Associated Spring Corporation. 158 pp.

HALF PAST WHEN. By Hassoldt Davis. Philadelphia: J. B. Lippincott Company. 283 pp. $3.

UP FRONT. By Bill Mauldin. New York: Henry Holt & Company. 228 pp. $3.

PROCEEDINGS OF THE INSTITUTION OF MECHANICAL ENGINEERS, January-December 1944, Vol. 151. London: Published by the Institution. 380 pp.

THESE ARE THE RUSSIANS. By Richard E. Lauterbach. New York: Harper & Brothers. 368 pp. $3.

COLOR AND DEMOCRACY. By W. E. Burghardt DuBois. New York: Harcourt, Brace & Company. 143 pp. $2.

AIRPLANE CRASH FIRE FIGHTING MANUAL. Boston: National Fire Protection Association. 96 pp. $1.

STEEL EXPANSION FOR WAR. By W. A. Hauck. Cleveland: Penton Publishing Company. 192 pp. $2.

FATE AND FREEDOM. By Jerome Frank. New York: Simon & Schuster. 375 pp. $3.

THE ANATOMY OF PEACE. By Emery Reves. New York: Harper & Brothers. 275 pp. $2.

PISTOL AND REVOLVER SHOOTING. By Walter F. Roper. New York: The Macmillan Company. 256 pp. $2.49.

ACTION TONIGHT. By James D. Horan. New York: G. P. Putnam's Sons. 171 pp. $2.50.

A SHORT HISTORY OF GERMANY. By S. H. Steinberg. New York: The Macmillan Company. 304 pp. $3.

IT SHOULDN'T HAPPEN. . . By Don Freeman. New York: Harcourt, Brace & Company. $2.